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THE FUNCTION OF THE CENTRAL ACOUSTIC NUCLEI EXAMINED BY MEANS OF THE ACOUSTIC REFLEXES.*†

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The drawing in Fig. 1 is a schematic representation of the cochlear system. When a tone strikes the cochlea nerve impulses are set up in the fibres of the acoustic nerve: those impulses are conducted first to the primary acoustic nuclei in the medulla, then to a series of secondary nuclei (internal geniculate body and oliva superior complex) and finally to the cerebral cortex and to motor nuclei. The impulses reaching the cerebral cortex give rise to acoustic sensations and allied phenomena, while the impulses reaching the motor nuclei set up reflex contractions of certain muscles (tensor tympani m., etc.).

Now we have, on one hand, that the primary acoustic nuclei are common to both the sensory and the reflex acoustic paths, and on the other hand, that according to recent work (Lorente de Nó, 1935, a-f) no important modification of the fundamental character of the trains of acoustic impulses can take place in the motor nuclei. Therefore the reflex responses of the muscles of the middle ear, if properly analyzed, will disclose

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some of the properties of the trains of impulses set up in the acoustic paths by tones striking the cochlea. Since the complex of the superior oliva has a structure much simpler than the primary acoustic nuclei, it has to be expected that any difference between the trains of impulses in the cochlear nerve and the impulses in the secondary acoustic paths will be due chiefly to the activity of the primary acoustic nuclei. The work of Weber and Bray (1931) and of the Harvard group (Davis, Forbes, Saul, Derbishyre and Lurie; resumé in Davis, 1934) has established that, on the whole, the impulses in the cochlear nerve reproduce, up to a certain frequency, the frequency of the tone and are the more numerous the stronger the tone.

There is considerable literature about the acoustic reflexes of the muscles of the middle ear; but practically all the experiments carried out had the purpose of ascertaining the function of those muscles and therefore have but little interest for the present problem. A good presentation of the literature may be found in the classical paper of Kato (1913). More recent work has been done by Lüscher (1930), Dahmann (1929, 1930), Kobrak (1930, 1932), Lorente de Nó and Harris (1933), Lorente de Nó (1933), Raymond (1932), etc. It has been established that when tones of sufficient intensity reach the ear, those muscles contract and diminish the amplitude of the vibrations of the drum membrane and chain of ossicles. The functional signification of their contraction is not yet clear. I would compare the function of the tensor tympani and stapedius muscles with that of the pupil of the eye.

Kato, Kobrak and Raymond determined the tonal range to which those muscles respond. It extends from 128 cycles up to the upper limit of human hearing and even beyond it. Lorente de Nó and Harris determined the reflex audiogram, *i.e.*, the threshold intensity for the different frequencies.

Technique: Records of the contractions of the tensor tympani muscle have been published by Kato and later by Kobrak. Both authors allowed the muscle to contract under almost isotonic conditions, *i.e.*, without developing tension. It is evident that records of that kind could not be used in the present investigation, because isotonic recording does not give an accurate measure of the strength of the contraction. Quantitative

determinations can be properly made only under isometric conditions, when the muscle is not allowed to shorten and the tension developed by its contraction is measured.

Since the maximal contraction of the muscle does not develop much more than 1 to 2 gm. tension the most suitable type of myograph is the so-called flat spring one. A steel spring of 41 mm. length, 0.9 mm. width and 0.07 mm. thickness is stretched between two clamps so that its own period of vibration becomes very high (well above 2000 cycles per second).* In its center the spring carries a small brass block with a plain mirror and a 3 to 5 mm. long arm, to which the muscle is attached by means of an inextensible thread.

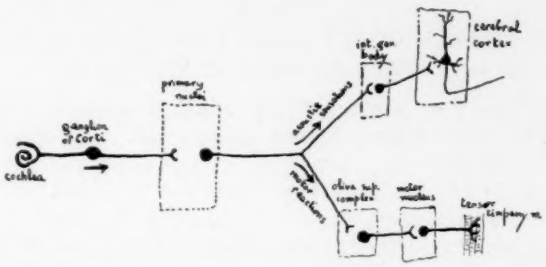


Fig. 1. Diagram of the constitution of the cochlear system. From the cochlea the nerve impulses go through the ganglion of Corti and cochlear nerve to the primary acoustic nuclei; here new impulses are set up, which go to the reflex apparatus (oliva superior complex and motor nuclei), thus giving rise to motor reactions (contraction of the tensor tympani muscle, etc.) and also to the sensory apparatus (internal geniculate body and cerebral cortex), where they start the process underlying the acoustic sensations.

A beam of light is reflected by the mirror and falls upon the slit of a photographic camera in which sensitized paper is being moved at a uniform speed (up to 30 cm. per second). When the muscle contracts the mirror rotates on the axis of the spring and the beam of light is deflected, thus recording the contraction upon the moving paper. Since the movements of the mirror are magnified more than 500 times, the contraction of the muscle is almost perfectly isometric.

The sound is produced by an audiometer built in the Bell Telephone Laboratories, which produces pure tones of any

*The instruments used in the present study have been built by Mr. H. Tuenge, Mechanician at the Central Institute for the Deaf.

pitch between 16 and 20,000 cycles at any intensity up to 140 decibels, in steps of 1 decibel. The duration of the tone is regulated by means of the rotary interrupter and relay box described in another paper (Blossom and Lorente de Nó, 1934). Further details of the technique were mentioned by Lorente de Nó and Harris (1933).

The rabbits were operated under deep ether anesthesia. The cerebral cortex was extirpated and the preparation allowed to recover from the narcosis.

All the experiments but one were made in 1933. A preliminary report was published that year (Lorente de Nó, 1933, c).

RESULTS.

1. THE RESPONSE OF THE TENSOR TYMPANI MUSCLE TO TONES OF LONG DURATION AND CONSTANT INTENSITY.

After the tone is started a certain time elapses before the tensor tympani muscle begins to contract. This time measures the latency (latent period) of the reflex reaction. The diagram in Fig. 1 shows that the latent period is made out: *a*. the time necessary for the impulses to be started in the cochlea and conducted through the cochlear nerve to the primary acoustic nuclei; *b*. the time necessary for the impulses for setting in activity the primary nuclei, the oliva superior complex and the motoneurones; *c*. the time necessary for the impulses to reach the muscle fibres and set up a visible response. Parts *a* and *c* are constant within narrow limits but part *b*, which measures the "central" reflex time, varies according to the nature and strength of the stimulus.

The myogram (see Fig. 2) consists of two parts: an initial part, S-shaped, during which the tension is established and a second one during which the tension is maintained. The slope of the myogram at the central part of the *S* is a convenient measure of the speed of the contraction. It has been found to increase with the intensity of the tone. The height of the plateau measures the tension developed by the pull of the muscle on the malleus and drum membrane; it also has been found to increase with the intensity of the tone.

The plateau is never exactly horizontal, besides the changes due to "fatigue," which will be considered later, it generally

shows oscillations of strikingly constant frequency. The oscillations are more pronounced in some rabbits and better visible in the response to certain tones.

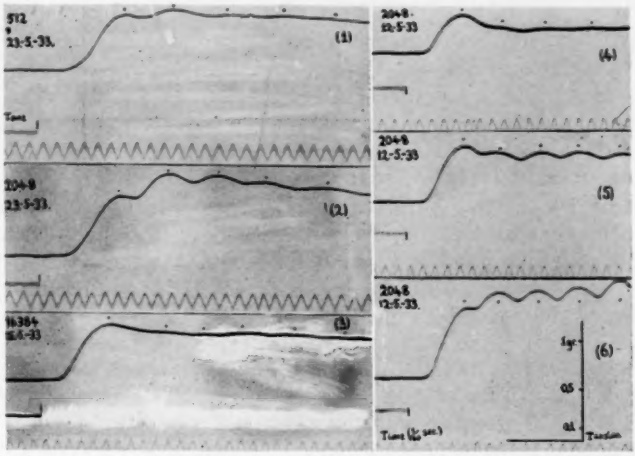


Fig. 2. Six reflex myograms of the tensor tympani muscle. In each record the upper line is the myogram; the middle one records the tone, when it breaks the tone begins; the lower line measures the time in one-sixtieths of a second.

Record 1 (Experiment of 23/5/33), 512 cycles tone of 33 decibels above reflex threshold.

Record 2 (same experiment), 2048 cycles of tone of 25 decibels above reflex threshold. Note that the waves in the myogram, marked with small dots, have a similar frequency in both records.

Record 3 (Experiment of 15/5/33), 16,384 cycles tone of 12 decibels above reflex threshold. The waves in the myogram are blurred and their frequency is irregular.

Records 4, 5 and 6 (Experiment of 12/3/33), 2048 cycles tones of 17, 25 and 30 decibels above reflex threshold. Note that in "4" the plateau is lower than the first peak; in "5," about equally high, and in "6," higher. The frequency of the waves is lowest in "4" and highest in "6."

Tension scale in grams for all six myograms in Record 6.

Reduction to one-half.

Fig. 2 reproduces six myograms, in all of which the oscillations are clearly visible. The crests of the waves have been marked with small dots. The oscillations in Myogram 3 are among the less marked, that ever were observed.

It was first thought that the undulations in the plateau were due to the following mechanism: The contractions of the tensor tympani and stapedius muscles reduce the amplitude of the vibrations of the drum membrane and chain of ossicles

(Politzer, Dahmann, Kobrak) and therefore diminish the intensity of the perceived tone, which of course brings about a reduction in the tension developed by the muscles and a drop in the myogram. But since the drop in tension increases the perceived intensity of the tone, the muscles have to contract again; a new relaxation will be then produced and so on. However, this theory soon proved to be insufficient because it may happen that after the first peak the muscle never attains again the original tension, as in Record 4 in Fig. 2; or the muscle may attain the same tension in each peak, as in Record 5, or else the oscillations may appear without actual relaxation of the muscle, so that with each oscillation the tension actually increases, as in Record 6; and all the changes may be observed with the same rabbit, using the same tone and not varying its intensity by more than 13 decibels. Undoubtedly, the oscillations are due to some property of the central cochlear mechanism.

The frequency of the waves in the myogram is not closely dependent on the pitch of the tone, because, for instance, in Fig. 2 the frequency is nearly the same in Record 1 obtained with a 512 cycles tone as in Record 2 obtained with a 2048 cycles tone. On the other hand, it increases with the intensity of the tone; for instance, in Records 4, 5 and 6 in Fig. 2 the frequency is lowest in Record 4 and highest in Record 6. However, the frequency varies only within narrow limits and is very closely the same in the different rabbits. Its limits seem to be 15 and 20 waves per second.

The waves are best seen in myograms obtained with tones of up to 5000 cycles; with higher tones their amplitude is generally small and not seldom they become irregular.

There are considerable differences among the individual rabbits as to the ability of the cochlear mechanism to maintain at constant level the contraction of the tensor tympani muscle. There are rabbits in which no fatigue is observed even with intense tones of half a second or even 1 second duration; but with other rabbits fatigue rapidly sets in and the contraction of the tensor tympani muscle begins to diminish even one-tenth of a second after onset of the tone. The diminution of the tension is always accompanied by a blurring of the waves in the plateau.

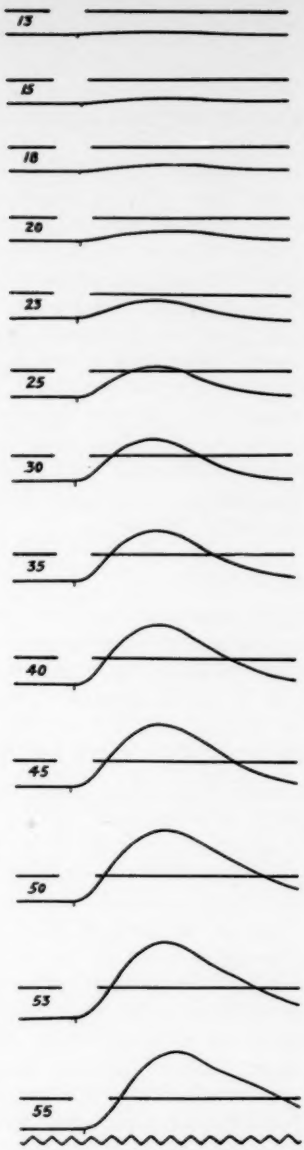


Fig. 3. A series of myograms obtained with a 1024 cycles tone of 30 sigmas' duration but of variable intensities. The intensity is given in decibels above reflex threshold in each record. Experiment of 18/2/34. The same tension scale as in Fig. 10 (IV. B). Time scale for all records in one-sixtieth second below.

Note that although the tension shows a very large increase the summit of the contractions are placed always almost at the same distance from the onset of the tone (Curve D B in Fig. 5). The latent period decreases with increase in intensity of the tone. (The onsets of the contractions are marked in the records; the distance between the onset of the tone and the onset of the contraction measures the latent period.)

In the three last records the relaxation phase shows a hump which suggests that a weak second cycle of contraction had been started.

The original records have been traced on tracing paper by a professional draughtsman, to reduce the expense of reproduction. Reduction to 4/11.

The "fatigue" of the reflex is dependent both on the intensity and pitch of the tone. With a moderately intense tone, say 20 decibels above reflex threshold, the contraction of the tensor tympani muscle may be maintained at constant level for several seconds. This is what happened in the responses illustrated by Records 4, 5 and 6 in Fig. 2. But if the intensity and pitch of the tone are increased, "fatigue" generally sets in and with very high tones, after a couple of seconds the muscle may relax totally and remain so during the whole duration of the tone. This is very apparent with the cat. Low tones up to about 5000 cycles, elicit sustained contractions, but high tones develop only very short, almost twitch-like contractions followed by relaxation of the muscle during the rest of the duration of the tone.

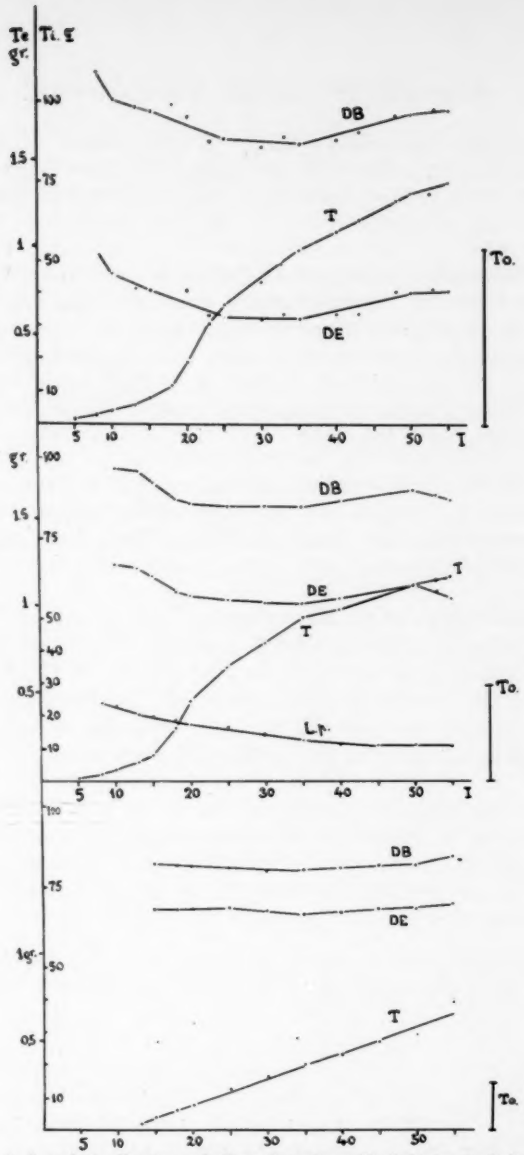
2. QUANTITATIVE RELATIONS.

Latent Period: Measurements made with perfected myographs at high speeds of the camera have shown that the tensor tympani muscle responds to intense tones after a latency of no more than 10 to 12 sigmas. The duration of the latent period is in inverse relation to the intensity of the stimulus, as shown by the *L.p.* curve in Fig. 5.

The assumption previously made (Lorente de Nó, 1933, c) that the latent period is in inverse relation to the pitch of the tone, cannot be substantiated yet. It is possible that such a relation exists (see later, temporal summation) but it seems that the important relation is that between the strength of response and its latency, so that to a certain strength of response measured by the tension developed it corresponds to a certain latent period; without much dependence on the pitch of the tone. This problem can be solved only by plotting the tension-latency curves for different tones, but unfortunately I do not have enough records obtained with the perfected myographs and I cannot consider the previously published ones (Lorente de Nó, 1933, c) as entirely reliable.

Tension: The tension developed by the muscle is the best measure of the strength of the reflex response; it increases with the intensity of the tone. As a measure of the tension it is best to take that developed at the first peak of the myogram, *i.e.*, when the plateau begins.* As a rule for tones of

*In previously published curves the tension was measured in the plateau; which explains the irregularities found.



Figs. 4, 5 and 6. Curves relating the strength, latency and duration of response to the intensity of the stimulus. Experiment of 18/2/34, 1024 cycles tone. The intensity of the tone in decibels above threshold is given in the abcissae.

Curve T measures the tension in grams (scale at left). Curve D B the distance from the onset of the tone to the summit of the contraction; Curve D E the distance from the end of the tone to the summit of contraction. (Scale in sigmas at right.)

"T o" measures the duration of tone (about 53 sigmas in Fig. 4, 30 sigmas in Fig. 5, and 12 sigmas in Fig. 6). Curve L p measures the latent period of the reflex in sigmas; it is of course the same for all three tone durations.

In comparing Figs. 4, 5 and 6 it has to be noted that the "D B" curves have approximately the same height, while the Curves D E occupy different positions; the "D E" curve in Fig. 6 is the highest, although the "T" curve is the lowest.

low intensity the average height of the plateau is less than that of the first peak, while for intense tones the height of the plateau continuously rises above the level of the first peak until "fatigue" sets in.

If the tension measured in grams is plotted against the intensity of the stimulus very characteristic curves are obtained (see Figs. 4, 5 and 6, *T*). In general it may be stated that the slope of the curves increase with the pitch of the tone (Lorente de Nó, 1933, c) so that with high tones the same logarithmic increase in intensity produces a larger increase in tension than with low ones.

The form of the tension intensity curve is very peculiar (see Figs. 4, 5 and 6, *T*), and cannot be represented by a simple mathematical function. Trials have been made to obtain simpler curves.

First it was tried to eliminate the effect of the contraction of the muscles of the middle ear on the side exposed to the tone, because those contractions might have an effect on the slope of the tension-intensity curve. If the intensity of the tone is raised, for instance, by 10 decibels the contraction of the middle ear muscles will reduce the increase of the amplitude of the vibrations of the drum membrane by say 8 decibels, so that the tension-intensity curve even in the case of a truly linear relationship between strength of response and logarithm of the intensity of stimulus ought to show a downwards concavity; such a concavity is actually found in the experimental curves.

This being so it was expected that by reducing the duration of the tone the relationship between tension and intensity would become much simpler; the maximal simplification had to be obtained with tones of such short duration that they had ceased before the muscles of the middle ear could develop any tension worthy of consideration. And in fact such a simplification was obtained although it later became clear that it was mainly due to an entirely different reason.

Tones of very short duration do not produce any plateau in the myogram; the muscle contracts, reaches a certain tension and immediately afterwards begins to relax; several of such myograms are reproduced in Fig. 3.

Figs. 4, 5 and 6 contain three tension intensity *(T)* curves, obtained with tones of different duration. The curve is still S-shaped with a tone of only 30 sigmas' duration (see Fig. 5); in fact this curve is almost the same obtained with tones of "infinite" duration. Since the tone ceased before the muscles of the middle ear had developed any worthwhile mentioning tension it is evident that the S-shape of the curve was due not to the action of the tensor tympani and stapedius muscles but to some property of the central cochlear mechanism.

For tones of very short duration, up to 10 to 15 sigmas, the tension-intensity curve is very simple; it has a slight upwards concavity but on the whole it can be said to represent a nearly linear relation between strength of response and logarithm of the stimulus (see Fig. 6). If the duration of the tone is increased the curve breaks and shows a downwards concavity. At first the concavity is found in the later part of the curve; it is obtained with intense tones. When the duration of the tone is increased the downwards concavity travels to the left and is obtained with tones of medium intensity. When the duration of the tone is 40-50 sigmas the downwards concavity has reached its earliest position in the curve; it is obtained then with moderately intense tones and further increase of the duration of the tone does not affect it (see Figs. 4 and 5).

It is a very striking fact that although the tension developed increases with the intensity of the tone the duration* of the contraction remains almost constant. This is demonstrated by the fact that in Fig. 3 the summits of the contractions are found almost at the same distance from the onset of the tone.

The *D B* and *D E* curves in Fig. 4, 5 and 6 show the same phenomenon; Curve *D B* measures the distance (in time) from the onset of the tone to the summit of the contraction, which also is the beginning of relaxation, and Curve *D E* measures the distance from the onset of the tone to the summit of the contraction. In each set (see Figs. 4, 5 and 6) Curves *D B* and *D E* run parallel to each other and are separated by a time distance equal to the duration of the tone, and the *D B* curves are in all three sets almost at the same distance from the base line.

*The position of the summit of the myogram is the best measure of the duration of the reflex contraction. The actual end cannot be determined because at the end of the relaxation phase the myogram nears itself asymptotically to the base line. But the points at which the tension has fallen to, for instance, one-half of the maximum, are found to be nearly at constant distance from the summit.

All this indicates that in spite of wide variations of duration and intensity of the tone which give rise to variations of more than 100 to 1 in the tension, the summit of the contractions are found very nearly always at the same distance from the onset of the tone.

3. THE DEPENDENCE OF THE STRENGTH OF THE REFLEX CONTRACTION ON THE DURATION OF THE TONE.

It seems that all the leading theories of hearing agree in that an increase in intensity of tone produces an increase in the size of the stimulated part of the organ of Corti, and consequently of the number of activated cochlear fibres. If this is true, and there are no good reasons to doubt it, the tension-intensity curves in Figs. 4, 5 and 6 can be considered to a large extent as an expression of what Sherrington has called spatial summation of stimuli. The effects of stimuli arrived simultaneously through different fibres summate and give rise to stronger reflex reactions.

The other type of summation of stimuli found in ordinary reflexes is the temporal one. Successive impulses arriving through the same fibres produce cumulative effects, so that the strength of the reflex reaction increases with the duration of the stimulus. This type of summation, if present in the cochlear system, should be evidenced by an increase in the reflex contraction of the tensor tympani muscle, parallel to the increase in the duration of a tone of constant pitch and constant intensity. Such a type of summation is easily demonstrated.

Figs. 7 and 8 contain two series of records of the responses of the tensor tympani muscle to a 1024 cycles tone. The intensity was maintained constant (12 decibels above reflex threshold in Fig. 7 and 35 decibels in Fig. 8). The duration of the tone was varied from 3 or 4 sigmas to about 100 sigmas. Fig. 9 contains curves obtained by plotting different quantitative data against duration of the tone. The *T* curves measure the tension developed at the summit of the contraction. The *D B* curves the distance (in time) between the beginning of the tone and the summit of the contractions. The *D E* curves the distance (in time) between the end of the tone and the summit of the contraction (*i.e.*, the beginning of the relaxation). The *L P* curves measure the latent period of the reflex.

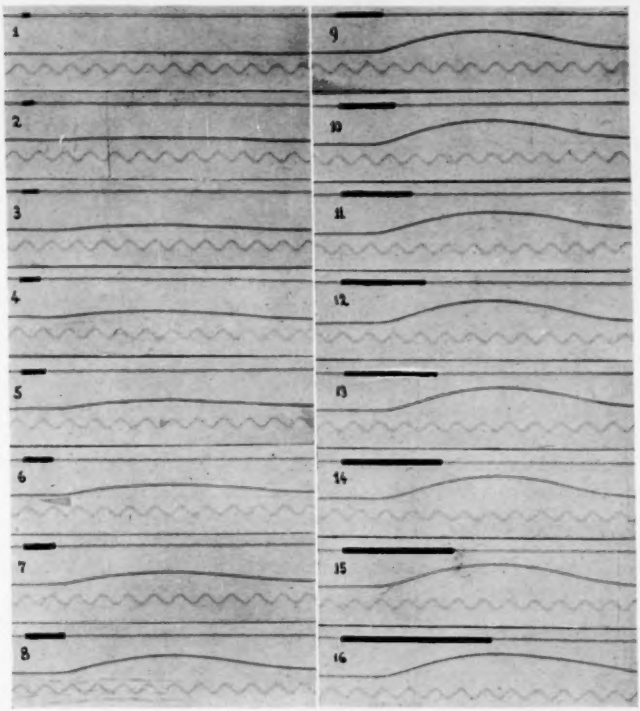


Fig. 7. A series of 16 records obtained with a tone of 1024 cycles at the constant intensity of 12 decibels above reflex threshold. The duration of the tone increases progressively from Record 1 to Record 16. Note that in Records 1 to 9 the increase of the duration of the tone by one or two vibrations produces a noticeable increase in tension, while between Records 10 and 15 practically no change is present, although the duration of the tone in Record 15 is more than twice that in Record 10.

These records have been used in the construction of Curves D B 1, D E 1, L P 1 and T 1 in Fig. 8.

In Record 16 the relaxation is checked by a hump, which undoubtedly represents an abortive second contraction cycle. (Experiment of 18/2/34). Reduction to one-half.

A comparison of both *L P* curves in Fig. 9 shows that the latent period was shorter when the tone was more intense; but both *L P* curves are horizontal lines, thus indicating that the latency of the reflex is to a very large extent independent of the duration of the tone. Instrumental difficulties have made it impossible to determine how many vibrations are necessary to obtain a constant latent period, but of course it may be stated that if temporal summation should diminish the

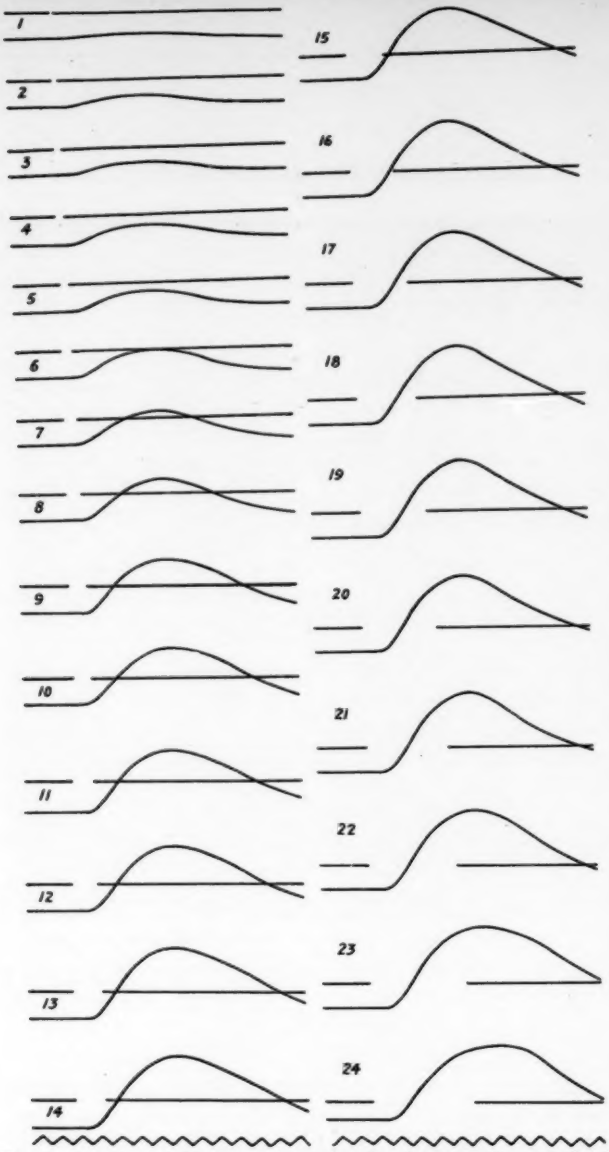


Fig. 8. A series of 25 consecutive records of contractions of the tensor tympani muscle in response to a tone of 1024 cycles at the constant intensity of 35 decibels above reflex threshold. The duration of the tone increases progressively from Record 1 to Record 24. These records have been used in the construction of Curves T 2, D B 2 and L p 2 in Fig. 9. They have been traced on tracing paper by a professional draughtsman. (Experiment 18/2/34.) Reduction to two-fifths.

The latent period is practically constant in all the responses.

The summit of the contraction is attained, from Record 6 on, practically at the same distance from the onset of the tone.

The tension increases rapidly from Record 1 to Record 13 so that the addition of one vibration to the tone produces a large increase in tension; however, from Record 13 on the increase in duration of the tone modifies the tension but slightly.

Note that the Records 14-21 are practically identical, only the relaxation phases show slight differences, which are similar to those observed if the same stimulus is repeated several times and therefore do not have any significance.

In Records 22, 23 and 24 a hump appears in the relaxation phase, which indicates that the duration of the tone is sufficient to reach the end of the period of depressed excitability of the primary acoustic nuclei and start a second cycle.

These 25 records are not selected ones; they constitute the whole series and were obtained at 3-minute intervals. They are therefore a good example of the extreme constancy and regularity of the tensor tympani reflex, which is hardly ever found in any other reflex reaction.

latency of the reflex it would be only during the first few sigmas of duration of the tone. In other words, the latency of the reflex is determined by the intensity of the very first vibrations and those arriving later cannot shorten it.

The tension however shows a very close dependence of duration of the tone. The initial part of the *T* curves (see Fig. 9) is an almost straight line, which indicates that the tension is proportional to the duration of the tone; on the other hand, the slope of those initial parts is proportional to the intensity of the tone so that the tension increases by virtue of temporal summation, the faster the more intense is the tone.

However, temporal summation does not persist for a long period of time and the *T* curves soon bend themselves and run as almost horizontal lines, which indicates that beyond a certain point the tension remains almost constant, no matter how long the tone lasts. The point at which the curve bends is the sooner obtained the more intense is the tone, so that temporal summation ceases sooner, or in other words, reaches its maximum sooner with intense tones than with weak ones. Thus, for instance, for the tone of 35 decibels (see Curve *T2*) the tension becomes constant at a tone duration of 25 sigmas, while for the tone of 12 decibels (see Curve *T1*) the tension becomes constant at a tone duration of 30 sigmas or more.

That the period of temporal summation is so short explains why in Fig. 7 all of the records after the tenth one and in Fig. 8 all the records between the fourteenth and twenty-first ones show practically equal deflections, although the duration of the tone varied very considerably.

Therefore it can be said that the strength of the response depends chiefly on the intensity of the vibrations arrived during a very short period of time (25 to 35 sigmas); vibrations arriving later increase the tension only slightly.

The *D B* curves are still more significative. They measure the time elapsed between the beginning of the tone and the summit of the contraction. The curves first rise, but soon, even sooner than the *T* curves, break and run almost horizontally. This has a clear signification. The duration* of the contraction is determined by the temporal summation of the

*See footnote, page 583.

impulses arrived during the first 10 to 15 sigmas of duration of the tone; impulses arriving later may still slightly increase the strength of the contraction, but do not increase its duration.

The same fact but in still more striking manner, is found in the *D E* curves which measure the distance in time between the end of the tone and the beginning of the relaxation. At first while the *D B* curve is rising the *D E* curve also rises; the duration of the reflex is being increased more than that of the tone, but when the *D B* curve bends into a horizontal line the *D E* curve begins to descend, and since it becomes a straight line of 1:1 slope (in the drawings due to the different scales in the *X* and *Y* axis, 2:1) it is evident that the beginning of the relaxation is independent from the duration of the tone. This is true for a tone duration of even 80 sigmas. Thus, it is found in Fig. 7 that while with a tone duration of 20 sigmas the muscle begins to relax about 65 sigmas after the end of the tone, with a tone duration of 80 sigmas the muscle begins to relax 10 sigmas after the end of the tone. Undoubtedly with duration of tone up to about 80 sigmas, the beginning of the relaxation is in no immediate relation to the duration of the tones.

Those unexpected results lead immediately to a very important conclusion:

When a tone of constant intensity and short duration is produced the cochlear impulses start in the primary acoustic nuclei a cyclic excitatory process; its latency is determined by temporal summation of impulses arrived during the first 3 or 4 sigmas; its duration is determined by temporal summation of impulses during the first 10 to 15 sigmas and its strength is determined chiefly by temporal summation of the impulses arrived during the first 20 to 30 or 35 sigmas. Impulses arriving later, up to 80 or 100 sigmas, produce a slight increase in the strength of the response but do not change the duration of the cycle. It seems as if after the cyclic process has been started and its duration and intensity determined, the primary cochlear nuclei should become inexcitable and could not be affected by later impulses. It is very significative that although changes in the duration of the tone may cause the intensity of the cyclic process to vary between very wide limits so that the tension developed by the muscle may show

100 to 1 variations, the duration of the process does not show more than slight variations (no more than 20 per cent). Neither does its latency show great variations. That cyclic process evidences the working rhythm of the primary acoustic nuclei.

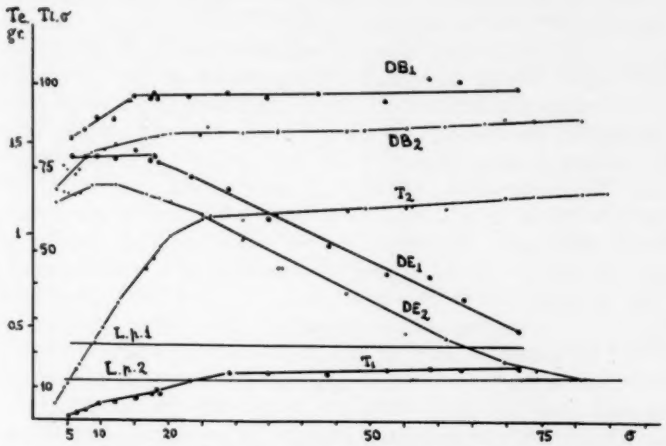


Fig. 9. Curves relating the strength and duration of the response to the duration of the tone; they have been constructed with the records reproduced in Figs. 7 and 8.

In abcissae the duration of the tone in sigmas, inordinates the tension developed (T) the distance from onset of the tone to the summit of the contraction (D B) and the distance from the end of the tone to the summit of the contraction (beginning of relaxation). The Curves 1 were obtained with a tone of 12 decibels above reflex threshold, the Curves 2 with a 35 decibel tone.

In comparing the D B curves in this figure and in Figs. 4, 5 and 6 it has to be taken into account that the experiment was of very long duration (over 6 hours) and many hundreds of reflex twitches were recorded. Between both series of records in Fig. 9 four other series were obtained at tone intensities of 15, 20, 25 and 30 decibels above reflex threshold. The duration of the reflex contraction is dependent on the state of the acoustic nuclei and therefore slight changes (only a few sigmas) are found from a series to the next one. Within the same series the state of the acoustic nuclei can be considered as constant.

If this conclusion were true, then when the duration of the tone is more than that of the cyclic process and impulses reach the acoustic nuclei at the end of their partially refractory period (period of depressed excitability) a new cycle should be started and a new contraction should appear. As a matter of fact, this is what happens.

Fig. 10 contains four series of records of responses to the 1024 cycles tone. Series I was obtained at an intensity of

15 decibels above reflex threshold; II, at 20; III, at 35, and IV, at 30. The duration of the tone was progressively increased from the upper to the lower record (17, 21, 85, 140 and 180 sigmas).

In Series I Records D, C and A show how the tension increased by virtue of temporal summation. The relaxation began in all the records practically at the same moment, and therefore the paradoxical fact was found that in *C* the relaxation began almost 80 sigmas after cessation of the tone, while in *A*, where the tension was more than four times larger, the relaxation began only 10 sigmas after the end of the tone. In Record B the duration of the tone was considerably longer and the contraction, which had reached its summit at the same point as in *A*, began to subside while the tone was still being produced. However, the latest vibrations arrived at the end of the period of refractoriness of the acoustic nuclei and were able to start a new cycle so that after cessation of the tone a new contraction appeared, which began to subside about 50 sigmas after the end of the tone. In Record E the duration of the tone was further increased so that the second summit was attained while the tone still was present; the tone however was not long enough to reach the end of the partial refractoriness of the acoustic nuclei due to the second cycle and therefore the muscle began to relax at the same time that the tone ceased. Although in *E* the tone had lasted almost 50 sigmas longer than in *B* both myograms are surprisingly similar.

In *E*, be it repeated again, the relaxation began immediately after cessation of the tone, but it was sufficient to *diminish* the intensity of the one by 5 decibels to obtain a contraction overlasting the tone by no less than 50 sigmas. The myogram is reproduced in *E1* (crossing through the time record). Due to the low intensity of the tone (10 decibels above reflex threshold) during its presence only one cycle was produced and the last vibrations instead of arriving during "refractoriness" of the acoustic nuclei, arrived during an excitable period and a second cycle was produced, the start of which, by chance, coincided with the end of the tone. The relaxation began about 50 sigmas after end of the tone. The conditions of Record B had been reproduced.

Series II, III and IV show how the increase in intensity changed the position of the peaks in the myogram.

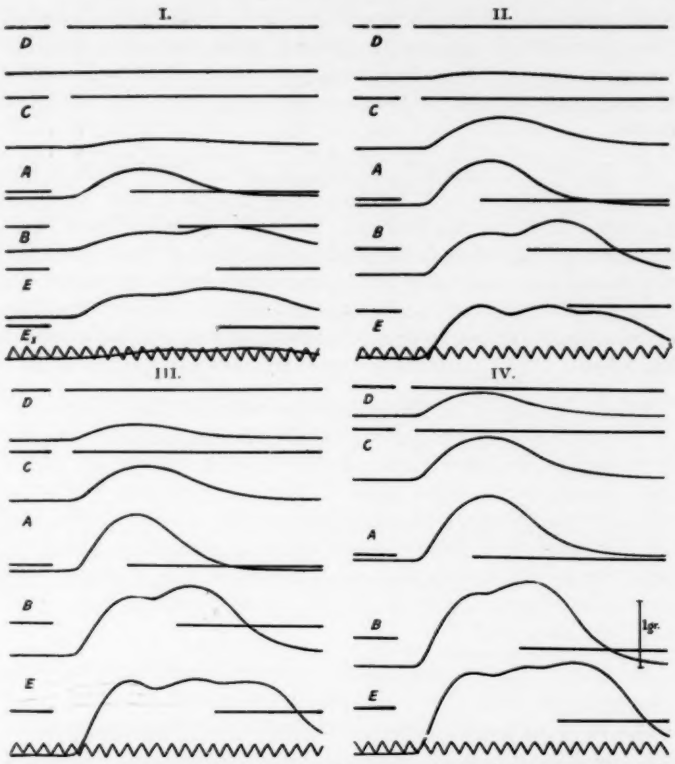


Fig. 10. It contains four series of records obtained in response to the 1024 cycles tone (Experiment of 2/11/33). In each series there are five records with tone duration of 16, 20, 85, 135 and 184 sigmas; but the tone intensity is constant in each series: 10, 15, 20 and 25 decibels above reflex threshold. Record E 1 in Series I was obtained at 5 decibels above reflex threshold.

The experiment was actually carried out so that in each series the tone duration was maintained constant and the intensity changed; the series of records were obtained in the order indicated by the letters A, B, C, D and E. But in order to facilitate the comparison the records have been arranged as if the series had been obtained with constant intensity but variable duration of the tone. This accounts for the slightly higher tension in Records A.

If the records bearing the same letter in Series I to IV are compared, the effect of increase in intensity of the tone is observed. But if the Records D, C, A, B and E of each series are compared one observes the increase in strength of response due to temporal summation. Note that in each series the effect of increase in duration of the tone upon the tension developed ceases in Record A; in the following records ("B" and "E") the changes in the myogram are due to the ability of the tone to start a second or even a third cyclic process of contraction.

Tension scale in Record I V, B. Reduction to five-elevenths. The original records have been traced on tracing paper by a professional draughtsman.

In Series II Records D, C and A again demonstrated the effect of temporal summation. In Record B the second cycle began while the tone still was present; but the

tone was too short to start a third cycle and therefore the relaxation began as in Record B of Series I. In Record E three cycles were found, two as in Record B, and a third weaker one which seemed to begin after the tone had ceased.

In Series III (Records B and E) the second cycle began earlier (the tone was 5 decibels more intense), and therefore the tone in *E*, which in Series II had reached only a short excitable period after the second cycle, reached the full excitable period and set up a full sized third cycle in which the muscle developed as much tension as in the two previous ones. The third cycle was found entirely after cessation of the tone.

Finally in Series IV the cycles were shorter, *i.e.*, the stronger impulses set up by the 5 decibels stronger tone were able to excite the acoustic nuclei earlier in their refractory phase and therefore the third cycle in Record E began while the tone still was present. And again, because a fourth cycle was not produced, the muscle began to relax very soon after the tone ceased. It would not have produced the slightest difference in the myogram if the last 20 or 25 vibrations of the tone had been omitted.

There can be no doubt that the enigmatic oscillations in the myograms of Fig. 2 are due to the repeated production of cycles in the acoustic nuclei, and that their frequency is not much dependent on the pitch of the tone, but very much so on its intensity. They reproduce the frequency of the working cycles of the acoustic nuclei.

Comment: The cyclic nature of the excitability of the primary acoustic nuclei has certainly been an unexpected finding but it is not without parallel in the nervous system. Bishop (1933) in a recent paper has demonstrated that the activity of the cerebral cortex is of cyclic nature. A stimulus delivered through the optic nerve sets up a wave of activity in the cerebral cortex, which is accompanied by a cyclic change of excitability, so that during a part of the cycle the cortex is refractory (inexcitable) and new incoming impulses remain ineffective. Later the refractoriness gradually disappears and at the end of the cycle the cortex recovers its normal excitability.

Of a similar character are the recent observations by Hughes and Gasser (1934), continuation of others by Gasser and Graham (1933). An impulse arriving to the spinal cord through one posterior root develops a potential wave of determined temporal pattern. While this potential is lasting a second impulse is unable to reproduce the potential wave; the cord is said to be in a refractory period.

Recently Dusser de Barenne and McCulloch (1934) have demonstrated in a most beautiful way refractoriness of the cerebral cortex after direct electrical stimulation and I may perhaps add that I have been able to demonstrate cyclic process in the trigeminal nuclei and in the reticular substance of the medulla (unpublished observations).

The cyclic nature of the activity of the nervous system was predicted in other papers in which the fine structure of the cerebral cortex and its physiology were examined (Lorente de Nó, 1934, a, b).

Although at the end it is possible that they prove to be quite different types of phenomena, I would not like to pass in silence the existence of phasic reactions in the vestibular system.

Bárány (1906-1907) observed that in humans, after rotations the postrotary nystagmus is followed, after a pause, by another nystagmus in the opposite direction (Nachnachnystagmus of Bárány). Buys (1925) observed this inverse nystagmus not only after rotations but also during the rotation after the first per-rotary nystagmus was over, and Fischer and Wodak (resumé in Fischer, 1929) have demonstrated after rotations the existence of several phases of nystagmus alternatively in opposite direction.

CONCLUSIONS.

1. When a tone strikes the ear the cochlear impulses start in the primary acoustic nuclei a cyclic excitatory process; the latency of the response is determined by summation of the impulses arrived during the few first sigmas of duration of the tone (no more than four); and its intensity by summation during the first 25 to 35 sigmas. After the cycle is started and its intensity determined, the acoustic nuclei enter in a period of depressed excitability, and the impulses arrived

during the latter part of the cycle produce only a small effect. When the cycle begins to subside the excitability is recovered.

2. The duration of the cycle is determined chiefly by the properties of the primary acoustic nuclei and not by the nature of the stimulus. On the average the summit of the first cycle is found 100 sigmas after onset of the tone; the duration of the cycle varies between very narrow limits, although the strength of the response may vary between very wide ones. The average frequency of the cyclic waves of excitability of the acoustic nuclei is about 20 to 25 per second.

3. The existence of summation in acoustic reflexes has been demonstrated; a consequence of it is that the strength of the response as measured by the contraction of the tensor tympani muscle depends both on intensity and duration of stimulus, and is proportional to both, if the tone ceases before the phase of depressed excitability of the acoustic nuclei begins.

4. The necessity of including the central phenomena in the study of hearing is emphasized.

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THE AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

The American Academy of Ophthalmology and Otolaryngology will meet in Cincinnati, Ohio, Sept. 14 to 20, to celebrate the Silver Anniversary of the Academy, as it now exists.

TREATMENT OF BRAIN ABSCESS.*

DR. P. G. FLOTHOW, Seattle.

Brain abscess, by virtue of its extremely high mortality rate, has long been a dreaded complication of septic processes in the body. Only recently has treatment been rationalized, to rank it now as one of the most favorable intracranial lesions with which the neurosurgeon has to deal. The latest phase of treatment concentrates on establishing adequate drainage, but as early as 1893, Macewen advocated that sufficient drainage should be provided with facilities for the extrusion of the abscess.

ETIOLOGY.

A study of anatomical structures from the developmental standpoint demonstrates various points of vulnerability by venous channels and perivascular spaces. As a part of the evolutionary process every cerebral vessel is surrounded by a prolongation of pia-arachnoid—a perivascular space—which substitutes for the outer coat in veins within the dura. Eagleton[1] has shown us that the veins within the dura as they pass into the sinuses, or extradural veins, exhibit certain points near the ear and nose which, were they to become diseased, could easily carry the infection into the brain substance. Aside from this direct extension, a brain abscess may present itself as the result of blood stream infection from a primary focus of suppuration. Named in order of importance the chief causative factors are: *1.* Direct extension from an accessory nasal sinusitis and otitic disease; *2.* extension following trauma to the skull, usually compound fractures; *3.* a hematogenous spread from distant septic lesions. Of the latter, we have found pulmonary abscess and chronic bronchiectasis to be the worst offenders.

There are many variations in the method of spread. Otitis media, for example, may have been of a mild transitory character and entirely healed, so that the patient does not connect

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it with the present inflammation. It has been contended that such a condition is quite general, the mode of infection probably being by a thrombosis of the venules of the middle ear, extending through the dura to the brain.[2]

As to type of infecting flora, any pyogenic organism may be the infective agent, but the most common are the streptococcus, staphylococcus and the pneumococcus. At times these are found in pure culture, while in some otitic processes we may have a multiplicity of type of micro-organism.

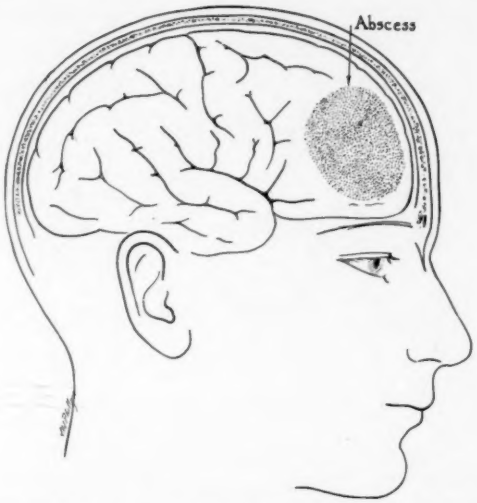

Fig. 1. Shows location of frontal lobe abscess in this case.

Otogenous origin holds first place as to incidence in most series of cases, the temporosphenoidal lobe being the most frequent point of infection in cerebral abscess. But the anatomical relationship between the lateral sinus and the cerebellum explains the frequency of cerebellar abscess from this source. Mixter[3] states that a chronic cerebellar abscess presupposes a co-existent thrombosis as a result of mastoid disease, and does not occur by direct extension. From a necropsy study of 194 cases, Evans[4] reports an incidence of 131 by direct extension, 109 of which were due to otitis media and mastoiditis. It is Mixter's belief that abscess from direct extension is less com-

mon than formerly taught, and that infection from septic thrombi is the usual medium of invasion. Perhaps, as Kopetzky once remarked, we are not all speaking the same language.

It is significant that out of 12 cases arising from suppuration within the nasal cavity, or its accessory sinuses, seven of Evans' cases occurred in subjects under 17 years of age, a period when the frontal, sphenoidal and ethmoidal accessory sinuses are in course of development. Osteomyelitis of the sinus wall with a resultant frontal lobe abscess is the com-

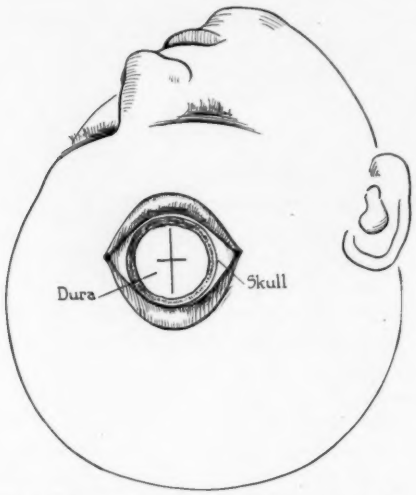

Fig. 2. Shows location of incision in scalp, trephine opening in skull and crucial incision in dura made with electrosurgical knife.

monest route and point of election for abscesses from this source. The close association between the frontal sinuses explains why the primary seat of the sinusitis does not always indicate the side of the brain involvement.

Fortunately, abscess formation is most common in the cerebrum, some writers placing the ratio as two to one in the cerebellum. In cerebellar abscesses the suppurative process is usually of small dimensions, though its form may be multiple, perhaps owing to the fact that embolic origin through the blood stream, according to some authorities, accounts for most

cerebellar lesions. When considered irrespective of mode of invasion, about one-half of all cases reveal multiple abscess.

To conclude, the favorite sites for this lesion are to be found: *1.* In the temporosphenoidal lobe; *2.* the frontal lobe; *3.* the occipital and cerebellar lobes. Frontal lobe abscesses are generally the result of direct extension from suppuration in the frontal, ethmoid and sphenoid sinuses. Mastoid disease often involves the petrous bone, through which route the majority of temporosphenoidal abscesses occur. On the other hand, cerebellar abscesses may come from the mastoid by way of the sheath of the auditory nerve into the posterior fossa.

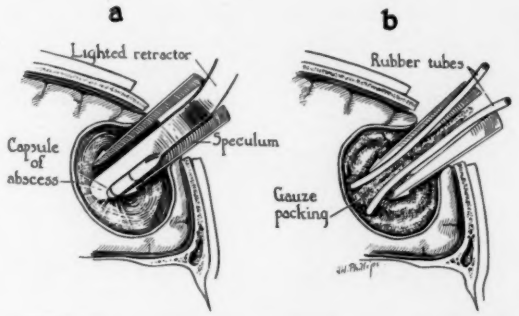

Fig. 3. (a) Speculum inserted into abscess cavity with lighted retractor for examination of abscess cavity. (b) Abscess cavity firmly packed with gauze and two rubber tube drains.

HISTORY.

Since, at the onset, an abscess is so frequently associated with an acute sinus infection, initial symptoms are often masked by the acute symptoms of that disease, often manifest to such a degree as to preclude diagnosis. This omission is frequently advantageous to the patient, for in few lesions is operation so lethal at the initial stage and so positively indicated later.

General acute early symptoms of brain abscess are those of any acute infectious process. Headache, chills and fever, toxemia, vomiting and convulsions are among the protean manifestations; and unless focal symptoms appear, brain abscess might not be suspected in the differential diagnosis.

The text book triad of headache, vomiting and choked disc, plus subnormal temperature and slow pulse are in reality systemic and local symptoms of the terminal stage, whereas in the acute phase the clinical picture differs. Headache in particular is characteristic; nausea and vomiting though common, are not always present; choked disc is rarely found early; and septic type of temperature and rapid pulse is more common than subnormal pulse and temperature. Frequently focal signs become demonstrable only to disappear rapidly on subsidence of the initial cerebral edema. Focal symptoms may be irritative, such as convulsive tics of cranial nerves, or Jacksonian or generalized convulsions, or at the other extreme, paralysis involving cranial nerves, extremities or a complete hemiplegia. Reflex changes or the appearance of pathologic reflexes may be the only focal signs.

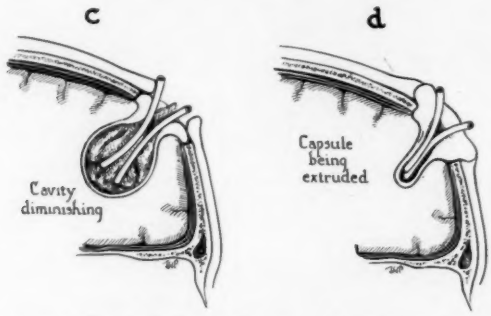

Fig. 4. (c) Showing beginning extrusion of abscess capsule and its contents. (d) All gauze removed with rubber tubes remaining in place and considerable herniation already occurring.

During the acute stage supportive and palliative measures are employed. It is frequently necessary to counteract the initial cerebral edema by means of spinal puncture, dehydration and limitation of fluid intake. After a few days these acute symptoms usually subside as the subacute and chronic stages ensue. When this is not the case, as in infections of the fulminating type which rapidly pass to a fatal terminus, we believe operation to be futile. Those who die during the acute stage could not be saved by early surgical intervention, which serves only to hasten the end and deprive the patient of any chance of arriving at the chronic stage. There seems to be no way of prognosticating if the case is to terminate fatally in the initial stage.

During the subacute and chronic stages the symptoms again abate, and if the condition has not been diagnosed during this quiescent period, our fears are lulled, and there is no diagnosis until an exacerbation of headache leads to a fundus examination revealing a full-blown choked disc. During the chronic stage, as a rule, there is a continuation of occasional headache, vomiting and a general lack of euphoria, although many patients are apparently normal.

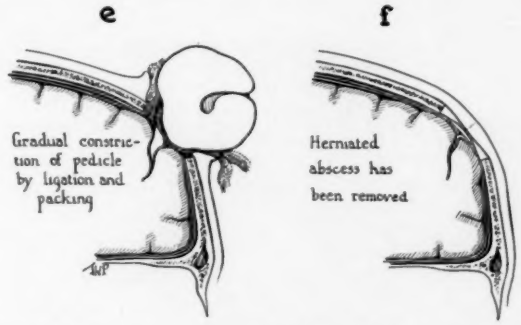

Fig. 5. (e) Showing entire abscess and its capsule herniated and lying external to cranial cavity with strangulating ligature applied. (f) Completed process with abscess completely extruded and removed.

It is during this stage that the utmost diagnostic and clinical acumen is necessary. In regard to successful waiting it requires fortitude to stand by knowing a brain abscess is present and to await the optimal time to intervene. In event the diagnosis has already been made, there is nothing more difficult to handle than that continual urge to operate by the patient's doctor and family. The former suspects you of "cold feet;" the latter may even "get someone who will operate." The average duration of symptoms varies with the virulence of the individual case, resistance and immunity being concurrent elements in deciding the course.

When we realize that the diagnosis of brain abscess but a few years ago called for immediate surgery, small wonder many of our patients died, since the principle is precisely that of operating on any other inflammatory process merely on noting its presence, without waiting for Nature's defenses to be mobilized. This is the key factor to successful treatment of

brain abscess, that it should be managed by the same fundamentals as abscesses elsewhere in the body. It is upon that working hypothesis, now thoroughly tested, that we can formulate the principles of modern treatment of abscesses. *First:* Wait until the abscess has completely formed, and Nature has walled it off from healthy tissue and called out her defense mechanism in order to develop a certain immunity to the infection. *Second:* The operation should provide adequate drainage and, if possible, exteriorization of the abscess cavity.

Fig. 6. Showing entire abscess having extruded itself and lying external to cranial cavity. Applicator projects into abscess cavity. Hemostats show the constricting ligature used to remove this mass.

By what criteria do we decide operation? The time is entirely dependent upon the condition of the patient. Up to a certain point the longer the interval, the better the encapsulation and the outcome. Our best results have been in cases in which a period of weeks and even months elapsed before the abscess was discovered, well illustrated by a case in point. A few years ago we were consulted on a case of frontal osteomyelitis, — a little boy who had a sudden generalized convulsion. The spinal fluid was normal, and pressure was not increased; as the other diagnostic findings were negative, brain abscess was decided against. When three months later the boy was referred with a full-blown choked disc, we were able to drain his abscesses and complete recovery followed. In this instance the original infection of the brain doubtless coincided with the time of the initial convulsion. This history is typical of many of our cases; several abscesses which followed mastoid disease were not diagnosed until months later.

Woltman[5] has given us a study of spinal fluid findings for the determination of the optimal time of drainage. During the invasive stage a definite pleocytosis was evident from 10 cells and up; it is during the chronic stage that the cell count returns to normal; whereas, at a noticeable increase, surgery should be instituted. Thus, the number of cells in the spinal fluid is in inverse proportion to the degree of encapsulation. We are in accord with Woltman who is convinced that the danger of spinal puncture has been overrated. Eagleton, however, does not countenance spinal puncture when there is a suspicion of abscess in the posterior fossa or any part of the midbrain that passes through the tentorial ring.

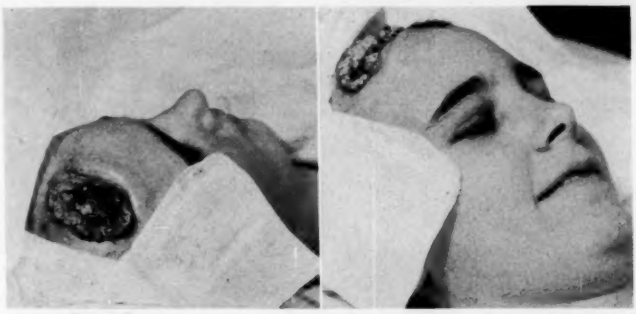

Fig. 7. Granulated area remaining after removal of extruded abscess.

When an exacerbation of headache and development of early choked disc or focal symptoms dominate the clinical picture, operation is then indicated.

TREATMENT.

The application of the second principle, that of adequate drainage, is accomplished by our technique to be later described. Macewen's early contribution is worthy of repetition. A rather wide opening of the abscess cavity with removal or turning back of the peripheral brain tissue for inspecting and cleansing the cavity was advised. He states: "Once the opening in the cerebral tissue is sufficient, the sloughs are extruded by the intracranial pressure and are carried slowly to the surface of the brain. . . . . The retention of such sloughs

is one of the most fruitful sources of reproduction of abscesses after evacuating the primary one, and is also the cause of delayed healing." To think that it has taken us 40 years to return to the fundamental principles!

The literature on the subject of treatment all points to simplicity in drainage, as trauma to the brain endangers life. Eagleton advises an osteoplastic flap with thorough inspection of the brain for localizing the abscess, and tube drainage for the lesion. Mosher and Cahill use the Mosher wire gauze

Fig. 8. Showing end results approximately three months after first operation.

basket which is inserted in the abscess cavity and gradually extruded. Sachs advises drains of rubber tubing. Coleman locates the abscess with a ventricular needle over which a cannula is placed. Should drainage be difficult, the insertion of a soft rubber tube through the tract into the abscess is advised. Dandy advocates the minimum of surgery, — simple tapping of the abscess either once or two or three times, but neither aspiration nor irrigation of the abscess. Most of the above described methods of treatment have the disadvantage that they do not allow for extrusion of the abscess capsule. The retention of this capsule with the inflammatory element is, we believe, frequently the source of recurrence and, furthermore, its retention is the factor that produces convulsive

seizures as time goes on. Adson and Craig[7] have described the technique, which, in our estimation, fulfills the principles of adequate drainage and exteriorization.

After the abscess has been localized as accurately as possible by neurological examination and, if necessary, encephalograms, an exploratory trephine opening is made directly over the supposed site. The capsule is then probed for with a cannula through a very small incision in the dura and arachnoid. Should the resisting capsule be found at an angle showing that the opening is not directly over the abscess, a second trephining should be made. By increasing the opening in the skull to about an inch or a little over in diameter, the dura can be incised the length of the exposure by means of the electrosurgical knife, which seals the dura and arachnoid to the cortex of the brain. If the sealing is not perfectly accomplished a few sutures may be necessitated. With the same unit the incision in the cortex is continued down to and into the abscess cavity, but the wound area must be well packed off with cotton previous to the entrance into the capsule. A nasal speculum with a flange designed to hold the abscess open, yet not to allow it to slip from the capsule, is then inserted into the cavity, which is gently washed out and cleansed with cotton pledgets. A lighted retractor is inserted in order to examine the walls of the cavity for assurance that there is no communicating abscess, after which the cavity is firmly packed with either iodoform or plain gauze, followed by the insertion of two small rubber tubes. The skin incision is left wide open and the entire area carefully packed. The wound is dressed daily, and extruded packing removed. Ten days to three weeks are usually requisite for the expulsion of the packing in its entirety. But if such is not the case, repacking plus the above procedure is continued until all the abscess cavity has found its way to the surface.

The hernia that forms upon extrusion of cavity may be treated in several ways. In one case with a rather small pedicle, daily packing of gauze so compressed the pedicle that the entire herniated abscess could be finally removed by a strangulating ligature. In cases in which the total process has been expelled, the pedicle is often cauterized.

After the foreign body is removed the only problem is to allow the open surface to granulate. Time is the essential

element in progress; a choked disc and many neurological findings may recede very slowly. The rationale of this whole line of treatment explains the eventual return to normalcy in the large majority of surviving cases. Not only is very little brain substance extruded, but there is practically no destruction of brain tissue. Since developing this method of treatment none of our cases have developed epileptic seizures. We feel that the reason for this is the fact that all infected and abnormal tissue has been extruded from the brain, thus obviating the necessity of scar formation.

The mortality has been greatly diminished, and we feel that the large majority of cases surviving the acute stage may be carried safely to a successful termination.

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903 Boren Avenue.

IONTOPHORESIS IN HAY FEVER AND ALLERGIC CONDITIONS.

DR. LESTER D. VOLK, Brooklyn.

Iontophoresis with the galvanic current is being viewed with renewed interest by the medical profession. Though this medical aid has been known and used for over 150 years, it has passed through cycles of enthusiasm for it, or again, because of some superficial explanation of an unfavorable finding, it has been relegated to the limbo of forgotten or seldom used therapeutic aids.

In the past decade, through the work and reported findings of Demetriades and Franklin,[1] in Europe, and Warwick,[2] in the United States, a new impetus has been given to the study of its uses and value in hay fever and allergic conditions by application to the nasal mucous membrane. Received at first with conservatism and with even a certain amount of skepticism, the effects were so immediate and definite that some rhinologists were tempted to try it, with surprising results.

Since the early part of 1934 the writer has used this form of treatment on numerous patients. A technique and apparatus has been worked out, cases have been carefully checked and followed, and some unexpected and unusual results noted. Those of interest will be reported here.

APPARATUS AND SOLUTIONS.

A smooth, galvanic current is obtained by rectification of the commercial alternating current through a circuit of mercury vapor tubes, transformers, filters and condensers. A rheostat, milliamperemeter and ohmmeter complete the apparatus. The current produced must be even, sustained and free from jerk. The outlets are so arranged that there is no possibility for error in polarity.

The electrolyte depends upon the type of case and consists of solutions of varying strengths of zinc, tin, cadmium, sodium

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or potassium, alone or in combination. This is freshly prepared and should be slightly acid in reaction. The electrode is a flat rod of amalgamated zinc, highly polished. All electrical connections must be clean and bright and so constructed that they cannot become disconnected during the treatment.

These details are extremely important since one is working in the nasal cavity in close proximity to the brain, the olfactory nerve and the sphenopalatine ganglion with its ramifications to the facial, trigeminal and vegetative nervous systems.

PRELIMINARY STEPS.

In allergic cases, examination of the nose usually reveals a pale, sodden, soggy mucous membrane, swollen and covered more or less with a thin, watery secretion. The respiratory space is almost closed; the inferior turbinate is edematous and hangs down almost if not to the floor of the nose; the mucous membrane in some cases appears polypoid.

About one-half hour before treatment the patient is given from 3 to 6 gr. of sodium amytal. The nose is irrigated with comfortably hot saline followed by a watery spray of 1 per cent ephedrine sulphate. The side to be treated is then packed with a 1 per cent solution of pantocaine in adrenalin chloride 1:2000. The effect sought is a temporary shrinkage and desensitization of short duration, but sufficiently long enough to enable a thorough and tight packing of the entire nasal cavity with cotton soaked in the electrolyte. Into this packing is tightly imbedded the electrode which is connected to the positive pole of the source of current.

The arm electrode consists of a thin layer of soft, close-mesh rubber sponge, chamois covered, with a backing of fine copper mesh or thin copper sheet into the center of which is connected the negative pole of the source of current. The dispersive area of this electrode should equal or exceed the covered surface area of the nasal mucous membrane. If too small, tingling results and the current action is greater here than in the nose. The sizes vary from 3 x 4½ in. to 4 x 5½ in. For some time before using, it is soaked in comfortably hot water (not saline), and it is fastened to the flexor surface of the forearm or the outer surface of the arm on the same side with the nasal cavity to be treated. A covering of rubber tissue over it retains the moisture and encourages sweating, thereby lowering skin resistance and improving conduction.

Constrictions about the neck should be loosened. Only one side is done at a sitting because of: *a.* patient's comfort; *b.* the reaction may be severe; *c.* for purposes of comparison.

Should pain or electrical shock occur at any stage of the treatment, it is evidence of faulty technique. Rapidity, thoroughness and efficacy should be the aim in applying this form of treatment. Sudden shocks must absolutely be avoided by gradual turning on and off of the current. Everything must be in position before the circuit is closed and nothing should be disturbed or touched until the circuit is opened again.

RESISTANCES AND THEIR INTERPRETATION.

The resistance of the human body has been variously estimated at from 1,000 to 10,000 ohms, the average being about 2,500 to 3,500 ohms. In the method under discussion, the initial resistance, *i. e.*, before treatment, depends on various factors.

1. Quality and amount of cotton and area and thoroughness of nasal packing.

2. Moistness of the cotton and its tight contact with the electrode and nasal walls.

3. Purity, smoothness and bright surface of the nasal electrode. Electrodes made up of a combination of metals are not to be preferred because unequal hardness and annealing produce electric couples due to the heterogeneous quality. Local currents thus set up lessen the efficiency of the metal as a conductor of the current by increasing resistance.

4. Bright and tight electrical connections.

5. Quality, size, preparation and application of the arm electrode.

6. Density, thickness, vitality, dryness or moisture of the skin; condition of and changes in the nasal mucous membrane.

The skin resistance may vary over wide limits, acting almost as an insulating medium; the normal mucous membrane of the nose offers the least resistance of all accessible body tissues. In the type of cases under treatment, the latter usually has undergone degenerative or nutritional changes.

An initial resistance up to 4,500 ohms, therefore, may be considered satisfactory, and indicates that proper contacts

have been made and that the amount of current desired will not require excessive voltage to force it through the circuit. This is a safeguard beyond which it is perilous to go. If on testing, the initial resistance should be found too high, look first to the connections; then to the arm electrode — moisture, contact and type of skin; then apply a small amount of current for a few minutes, open circuit and test again. In many instances it will be found that an initially high resistance will drop to within safe limits thus eliminating the necessity for repacking the nose. Packing of the nose is the most formidable and trying part of the treatment for the patient, and the necessity for a repacking may be avoided by strict care at every step.

METHOD OF TREATMENT.

Presupposing attention to every detail as evidenced by a low initial resistance, patient and instrument being ground free, the current is turned on and gradually increased up to the point of maximum dosage decided upon. Tingling may occur in the arm electrode which should subside in about half a minute. If it continues, the current must be turned off and an examination made of the arm electrode to determine the cause. As the current increases, the patient notes a metallic taste and there is increased salivation and lachrymation and flushing of the face; there may be a feeling of tightening of the throat or constriction of the neck; or of weakness or anxiety. The latter usually pass off while the former may persist all through the treatment and for some time thereafter.

The current strength and length of time of application are a matter of judgment and experience. The rule may be laid down that *the current must be sufficiently strong to accomplish the result sought for in the shortest possible time without injury to the patient.* A dose of from 80 to 125 milliampere minutes is usually sufficient.

After the packing is removed examination reveals a shrunken and wrinkled mucous membrane thinly coated with a white or grayish coagulate. The patient complains of a sharpening of the nerves of the face, jaws, teeth and gums, and a feeling of constriction about the head or a headache. Vomiting may occur. These symptoms usually pass off as suddenly as they came, in from four to seven hours, and are controlled by rest in a quiet room and mild sedation. The coagu-

late may continue to increase until it obstructs the nose. It comes away without difficulty in from three to five days, occasionally in one large piece similar to a cast of the nasal wall. Laboratory examination of one such piece showed it to be "mucus."

There was no discernible evidence of injury to the mucous membrane in any of the cases. To the contrary, after removal of the coagulate, the mucous membrane has a pink or reddish velvety and healthy appearance. In one case violent blowing of the nose caused a tearing away of the coagulate from the inferior turbinate leaving a raw bleeding area which healed rapidly with simple applications of bland oil. In no case has any interference with the sense of smell followed nor was there any evidence of atrophy of the mucosa. Alden[3] reports that sections of middle turbinates removed one to seven months after this form of treatment without exception showed intact and normal mucosa.

Polypoid tissue and hypertrophies become perceptibly smaller following iontophoresis. In exceptionally difficult cases due to anatomical abnormalities, treatment may be limited to one side, making the patient sufficiently comfortable to go through the season, after which operative procedures may be instituted.

CASE HISTORIES AND OBSERVATIONS.

Case 1: J. A., female, age 48 years, vasomotor rhinitis and asthma, frontal pains, nasal obstruction with thin, watery discharge; unable to sleep lying down. Allergy tests negative. Previous treatment, local and injections with no result. Septum slightly deviated to left, pale mucous membrane.

Jan. 26, 1934: Left side iontophoresis. I.R. 6,000 ohms, after 2,800 ohms. C.S. 10 ma. for 12 minutes. Reaction moderate. Beginning four days after treatment, patient was able to lie on her back without discomfort. Less obstruction and discharge on the left side.

Feb. 15: Right side iontophoresis. I.R. 8,000 ohms, after 1,800 ohms. C.S. 10 ma. for 12 minutes. Reaction severe.

Result: No further symptoms.

May 7: At her insistence and to allay the fears of the patient that the improvement might not be permanent (?), another treatment was given. Left side iontophoresis. I.R.

1,100 ohms, after 800 ohms. Reaction moderate and patient stated that she "felt" the treatment more in the nose than the first time. The clearness with which patients describe the subjective effects is a very interesting phase of this treatment. A comparison of the resistance with that of Jan. 26, would seem to indicate a condition of the mucous membrane more nearly normal.

Case 2: S. R., male, age 20 years, hay fever and severe vernal catarrh for four years. Burning, itching and stringy discharge from the eyes, conjunctiva and sclera severely injected, photophobia; sneezing and nasal discharge. Allergy tests positive for timothy, plantain, dust and ragweed, the last two very marked. Previous treatment, four injections twice weekly, preseasonal, and four injections three times a week, coseasonal, extending from April to September. Stopped injections on April 25, 1934. Examination shows unusually roomy nasal cavities, mucous membrane allergic, all sinuses dark on transillumination.

May 5, 1934: Left side iontophoresis. I.R. 800 ohms, after 700 ohms. C.S. 7.5 ma. for 10 minutes. Continued at work after treatment.

May 7: Reaction slight, less itching and discharge of left eye. Sclera clear compared with right.

May 10: Eyes clear. Small coagulum removed from treated side; mucous membrane appears firm, reddened and velvety. Right side has allergic appearance.

May 15: Reports slight itching and discharge, but no sneezing. Having occasion to ride through park, treated side caused no symptoms, but on the untreated side felt a burning, itching and discharge. Describes a "peculiar feeling as though the right and left sides did not belong to the same head."

May 19: Right side iontophoresis. I.R. 2,500 ohms, after 800 ohms. C.S. 10 ma. for 10 minutes. Reaction slight.

July 2: Feeling fine. No symptoms except occasional slight itching of eyes. Nasal mucous membrane appears reddened, sinuses clear, eyes clear. No nasal discharge.

Aug. 13: No symptoms. Before treatment, had to wear dark glasses and used almost a box of soft paper tissue a day for discharges. Now uses one handkerchief a day and hardly needs that.

Result: Marked improvement. Complete absence of symptoms.

Case 3: H. V., female, age 15 years, rose fever and ragweed for several years. Previous treatment, injections and calcium therapy with no improvement. Severe paroxysms of sneezing even in her sleep, nasal obstruction and discharge; eyes water and itch — severe in May and June, and in the fall. Examination shows a tall, thin female, small busts and narrow hips, weight 98 pounds; thin long nose, very narrow nasal cavities, deviated septum to the right with polypoid right middle turbinate.

May 26, 1934: Right side iontophoresis. I.R. 600 ohms, after 1,000 ohms. C.S. 8 ma. for 10 minutes. Reaction severe. Almost immediately began to feel general aching, pains in head, face and teeth, severe vomiting, salivation and weakness. These lasted for five hours, then tapered off and were gone the next day.

June 2: Improved. Irritation of eyes and nose gone.

June 5: Left side iontophoresis. I.R. 2,000 ohms, after 1,200 ohms. C.S. 10 ma. for 10 minutes. Reaction moderate although dizziness and vomiting continued for two hours.

June 15: Occasional sneezing, but no paroxysms. Close proximity to roses caused no return of symptoms.

The improvement continued through the summer and fall. Shortly after the treatments, began to gain weight and busts and hips became more developed. There was a marked improvement in her general appearance. Weight 112 pounds.

Result: No symptoms during the early or late season.

Case 4: M. M., male, age 30 years, hay fever four years, severe asthma two years. Tests positive for early spring (?). Previous treatment, injections with little effect. Complaints: asthma and usual nasal and eye symptoms. Examination showed deviated septum to right and spur on left side extending almost midway posteriorily, shaping cavity like a reversed 3, which made placing of the electrode very difficult.

May 22, 1934: Left side. I.R. 5,000, after 1,250 ohms. C.S. 12 ma. for 14 minutes. Reaction severe. Severe pains in head, nerves of the face and teeth and weakness. Pulse accelerated

but of good quality. In view of the patient's condition and obstacles to treatment, this was not entirely unexpected.

May 25: Large coagulum removed, resembling cast of mucous membrane. Asthma improved beginning the day following treatment. Still some slight itching of the eyes. "Feels better." On riding through the park the treated side gave no symptoms and felt different from the other side.

May 31: Right side. I.R. very high. Preliminary dose of 4 ma. for 5 minutes. R. 5,000 ohms, after treatment 1,500 ohms. C.S. 10 ma. for 12 minutes.

July 12: No symptoms since treatment.

Case 5: S. J., male, age 41 years, hay fever for 7 years. Tests positive to timothy, birch, dust, ragweed; no food tests. Injections simply shortened attacks but did not lessen severity. Had polypectomy seven years ago. Complaints: asthmatic feeling, anosmia, pressure between the eyes, nasal obstruction, sneezing, redness and irritation of the eyes.

June 1, 1934: Left side. C.S. 10 ma. for 10 minutes. Reaction severe.

June 7: Large coagulum removed. Polypoid condition improved.

June 16: Right side. C.S. 9 ma. for 14 minutes. Reaction moderate.

June 18, June 21: Marked improvement. Mucous membrane firm, large polyps noted on both sides.

July 31, Aug. 21: No symptoms except obstruction. "Feels fine."

Oct. 14, Oct. 28: Bilateral polypectomy. Many large polyps removed. In November sense of smell had returned, appetite improved and had taken on weight. "Never felt better in years."

Case 6: N. W., male, age 23 years, rose and late hay fever six years. Positive to timothy and ragweed. Injections last year, and four and five years ago. Effect doubtful. Usual symptoms.

May 31, 1934: Left side, 10 ma. for 10 minutes. Severe reaction.

June 9: Right side, 10 ma. for 10 minutes. Moderate reaction.

June 28: No symptoms. Dec. 2: "Had no trouble through season."

Case 7: F. C., female, age 37 years, hay fever 10 years. Positive to ragweed. Injections and phenol applications previously. Usual symptoms.

July 18, 1934: Left side, 10 ma. for 12 minutes. Reaction moderate.

July 24: Right side, 10 ma. for 10 minutes. Reaction slight.

Result: Improved. Occasional obstruction and sneezing. This patient, however, persisted in using other methods including room air filters, etc.

Case 8: S. S., male, age 29 years, hay fever and asthma for seven years. Positive to ragweed. Injections for five years which were always followed by an urticaria, but little relief. Highly nervous type. Perforation of septum over half inch in diameter following submucous resection.

Aug. 2, 1934: Left side. I.R. 2,700 ohms, after 900 ohms. 8.5 ma. for 10 minutes. Reaction severe, large coagulum.

Aug. 12: Right side. I.R. 2,500 ohms, after 1,200 ohms. 10 ma. for 10 minutes. Reaction moderate, small coagulum.

Result: Very comfortable throughout season except for the fear that he might get an attack the nature of which he could not describe.

Case 9: G. P., female, age 26 years, hay fever four years. Ragweed. Injections perennial and coseasonal for 2½ years, slight effect. Pregnant, and for that reason no injections this year. With some misgivings and great caution left side was given iontophoresis, 7.5 ma. for 7 minutes.

Result: Some improvement.

Case 10: M. S., female, age 29 years, hay fever Aug. 15 to frost, five years. Ragweed. Local treatment and injections with no effect. Usual symptoms. Examination shows considerable hypertrophy of nasal mucous membrane, right inferior turbinate hangs to floor of the nose. Eyes reddened, discharging and itch.

June 5, 1934: Left side. I.R. very high, after preliminary treatment came down to 4,500 ohms; after treatment, 1,400 ohms. 10 ma. for 12 minutes. Following this, itching of eyes and discharge stopped and no sneezing.

June 20: Right side. I.R. very high; after preliminary treatment was 4,000 ohms; after treatment, 1,800 ohms. 10 ma. for 12 minutes.

Aug. 17: Patient states, "Feels like a cold." Itching of the eyes but no discharge; some nasal obstruction, allergic appearance.

Aug. 30: Right side. I.R. very high despite two packings, registering 16,000 ohms. Preliminary treatment, 3 ma. for 5 minutes, R. came down to 4,500 ohms; treatment 10 ma. for 5 minutes; third packing was inserted, R. 3,500 ohms; treatment 10 ma. for 5 minutes, and at end of treatment R. was 1,600 ohms.

In this case it will be noted that in spite of attention to every detail the initial resistance remained high. Checking of all steps pointed to the nasal mucous membrane as the cause. The symptoms in this case continued with moderate severity through the season. This case is receiving routine nasal treatment and will be retreated next season if symptoms warrant it.

Result: Slight improvement.

Case 11: J. C., female, age 27 years, hay fever and asthma for 20 years. Positive for timothy, dust and ragweed; food tests indefinite. Local treatment and injections irregularly; history of three previous attacks of closed empyema of the antrums. In February, 1934, while in the south, had a pelvic operation which was followed one week later by a typical "hay fever attack."

Aug. 14, 1934: Left side. I.R. 4,500 ohms, after 1,400 ohms. 8 ma. for 10 minutes. Reaction indefinite because the husband, a physician, administered an opiate. The sinuses flared up, but cleared under appropriate treatment.

Result: No symptoms during season, patient being very comfortable. The right side was not treated.

The following, however, is of especial interest. Since childhood, this patient has been subject to attacks of diarrhea, six

to eight movements a day, lasting one or several days, at no regular intervals and no traceable connection to food. This was variously diagnosed as colitis, spastic colitis (X-ray), and allergy. Treatment did not seem to affect it.

Since the iontophoresis, the diarrhea has stopped except for one attack which was directly traceable to smoked spiced beef which she had eaten. (June 15, 1935. As the proofs of this article are being read before going to press, there has been no return of symptoms in this or any of the early season hay fever cases or those of the vasorhinitic type — AUTHOR.)

EXPLANATORY.

The effects produced by the treatment are both local and systemic. After the first reaction passes, the relief from symptoms is appreciated by the patient almost immediately. Why this is so, is not easily explained, but the following interpretation of the cause seems most logical:

1. Mild electrochemical cauterization of the mucosa of the nose produced by the decomposition of the electrolyte through the action of the galvanic current.

2. Contraction of the unstriated muscles under the influence of the positive pole, resulting in a squeezing out of the serum and lymph from the tissues.

3. Catalytic action of the negative pole on the lymph and serous fluids of the tissues resulting in a setting free of oxygen in the positive zone and carbon, nitrogen and hydrogen in the negative zone. This causes a coagulation.

4. Nerve tonus due to passage of the current in one direction over a relatively long period of time.

5. Some electrobiochemical effect on the body fluids not clearly understood, causing changes which make the system less sensitive to the irritant. This may be due to some protein reaction brought about by factors 2 and 3.

SUMMARY OF RESULTS.

Of the 11 cases reported here, following treatment there was amelioration of symptoms in all. One may be classed as indefinite; here, the resistance remained persistently high and

further investigation will be made. Of unusual interest are the results in Cases 3 and 11; in the former, immediate stimulus to development took place in an adolescent female, when the inhibitory influence of the allergic condition was removed; in the latter, an irregular and intractable diarrhea of allergic origin of 20 years' standing was stopped, after failure of all other tried methods. In this case, the fact that the history was followed by patient's husband, a physician, lends added credibility to an otherwise unusual and unexpected result.

IONTOPHORESIS VERSUS DESENSITIZATION.

Treatment of allergic conditions of the human body by parenteral injections has been reduced to a semblance of exactness, but there is no way to anticipate the variable, sudden and often dangerous reactions which not infrequently take place. In order to determine the offending protein, exhaustive preliminary diagnostic tests must be made with dilutions of specific irritants. These may be of one or of many types and of varying intensities of irritation. Densensitization methods require injections of solutions of protein extracts, single or mixed or multiple, coupled with an attempt to regulate the proportions in accordance with the varying degrees of sensitivity based on minute doses of one or more irritants. To this must be added the ability to interpret and evaluate subjective symptoms, which, at best, is a very variable factor. They are painful, tedious and transitory, and must be repeated each year or season.

Iontophoresis is a reliable, reasonably safe and rapid method, and aside from the immediate temporary reactions which follow the treatment, causes little inconvenience to the patient. It is practically standard regardless of the offending irritant and consists of one application to each side of the nose. It may be used at any time of the year, but preferably should be applied just before or during the seasonal attacks. The reported results of Franklin and Warwick, based upon their observations over a period of years of patients treated by this method, indicate that the relief from symptoms in most cases is permanent. Should this be confirmed by other workers in this field, then we have indeed something of value. These sufferers will willingly change to anything to get away from the "needle."

SUMMARY OF FINDINGS.

1. Iontophoresis offers us a valuable and reliable additional aid for the relief of allergic states of the human body.

2. The beneficial effects are both local in the nasal and adjacent cavities and general in the relief of remote symptoms.

3. No damage results to the nasal mucous membrane or its functions; to the contrary, hypertrophies and polypoid changes show a tendency to subside.

4. Allergic conditions, patent and masked, are relieved.

5. With our present knowledge, iontophoresis is contraindicated in acute infectious and purulent conditions and should be used with caution in the presence of subacute conditions.

6. It may be applied at any time, but preferably just before or during the period of seasonal attacks.

7. Close attention must be paid to detail and to selection of proper apparatus, electrodes and solutions, and great care exercised in their use.

8. This treatment should be given only by those specially trained in its application and qualified to carry it out.

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THE RESPONSE OF ALLERGIC PHENOMENA TO IONIZATION.*

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Ionization or iontophoresis has, for many years, been used in the treatment of various diseases of the skin and mucous membranes. One of the first references to its use in the nose was that by Baber[1] published in 1898. He suggested its employment in the treatment of nasal hydrorrhea and in the light of our present information it is probable that many of his watery nose cases were really allergic in origin. At one time or another, ionization has been employed in the treatment of almost all of the obstructive or infective diseases of the nose. Fox,[2] Hollender and Cottle,[3] Harris,[4] Feldman,[5] Gale,[6] Smith,[7] Cahill,[8] McCoy,[9] Sputh[10] and McCurdy[11] have each reported on the use of the galvanic current and solutions of zinc or other metals in the treatment of these various nasal conditions.

In 1927 Demetriades[12] reported that ionization of the nasal mucosa, using a weak galvanic current and a calcium electrolyte, gave relief in certain cases of seasonal and perennial nasal allergy. Franklin,[13] in 1931 and again in 1932,[14] announced definite successes in the treatment of these conditions by the use of zinc ionization.

Warwick,[15] in 1934, reported a large series of cases which had obtained partial or complete relief from their allergic symptoms following ionization with a combination of both zinc and cadmium in the electrode and electrolyte.

Ionization depends upon this principle: When a galvanic current is passed between two electrodes which are immersed in a conducting solution, positively charged metallic ions pass from the cathode and are deposited upon the metallic anode. When certain areas of the body are substituted for the conducting solution, the same principle holds good and the ion

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carrying current passes from the positive to the negative pole, the intervening tissues merely acting as a conductor. At first it was supposed that the action of the treatment upon the tissues contiguous to the cathode was due to metallic ions which were driven into the tissues. This has been definitely disproven. Lierle and Sage[16] examined tissues removed from ionized ears of animals and after careful chemical and spectroscopic study found no evidence that metallic zinc had actually penetrated the tissues during the process of ionization. However, a surface change in the mucosa exposed to the charged electrolyte does take place.

At the expiration of a nasal ionization, using a zinc electrode and a salt of zinc in the electrolyte, the mucous membrane is covered with a gray deposit, which is probably a mild surface coagulation. That this is not due to the chemical action of the electrolyte solution alone has been definitely proven. Hollender[17] tested this in control patients where noses were packed in every way similar to the preparation for ionization, but no current was used. The results were entirely negative in each case. The writer ionized five patients, doing the left side of each case in the routine manner. On the right side of each of these patients, saline was substituted for the zinc sulphate electrolyte and the same electrode and same time-ampere ratio was given. The results on the side where saline was used were entirely *nil* and each was reionized in the standard manner a few days later. Thus, neither the electrolyte nor the galvanic current alone can produce the reaction, but the proper combination of the two is a prerequisite for success.

My experience with ionization in the treatment of hay fever began the first week in September, 1933, when Dr. Warwick was kind enough to come to St. Louis and demonstrate this procedure to me. The results in the demonstration cases were so prompt and satisfactory that I decided to investigate this treatment more thoroughly on a group of my own cases.

During the 1933 season we ionized 19 cases of typical autumnal hay fever. One of these patients was a child, age 10 years, in her third season of the disease. The others were all between 22 and 58 years. All of these cases were ionized during the period when the symptoms of the disease were definitely manifest, and four of the adults also had asthma

at time of the ionization. Eleven of these patients had previously been treated by desensitization with unsatisfactory results. Five had received only local treatment and three, including the child, had received no treatment of any sort.

The result of the ionization in this group was immediate and complete relief in each case of allergic symptoms for the remainder of the season. The promptness with which the eye symptoms and the nasal itching abated following the treatment was little short of spectacular. In all of these cases the nose was entirely blocked with a membrane the day following the ionization. This membrane remained in place for three to four days, then began to loosen and was, as a rule, entirely gone by the end of the sixth day. Immediately following the expulsion of the membrane, the nasal mucosa was found to be reddened and quite sensitive, but this condition subsided very rapidly and by the end of the second week all noses appeared to be normal.

Since this first season we have used this method of treatment for all of our cases of both perennial and seasonal nasal allergy. Our percentage of complete relief has varied from 60 to 70 per cent, depending upon the type of the disease and the seasonal timing of the treatment. Our total failures have been less than 20 per cent. During the year of 1934 we found that those cases of hay fever which were ionized prior to the beginning of the disease presented a much larger number of recurrences than the group treated after the onset of their symptoms. There were some exceptions to this rule, however, and we were at a loss to explain several of our failures.

In an effort to learn more about the mechanism involved in the symptomatic relief that so frequently followed ionization and yet in other apparently similar cases failed, we had a group of patients studied from an immunologic standpoint before and after the treatment. These patients were treated in the Washington University Out-Patient Department after a careful allergic history had been taken and rhinologic examination done by one of the members of the Staff. This included a cytologic study of the nasal secretions in which the percentage of eosinophiles was estimated, intradermal skin tests done, positive reactions measured with a planimeter and recorded in square centimetres. The presence of specific reagins was determined by the usual passive transfer of blood

serum to the skin of a nonsensitive individual. The patient was then ionized and these same procedures repeated and recorded at the end of two weeks and again three months later. This work was done under the direction of Dr. H. D. Alexander[18] and reported in detail by him in the March, 1935, *Journal of Allergy.*

Although this was a relatively small number of cases, it was noteworthy that the group in which ionization gave the best results were those in which reagins in the blood serum were absent or present in small numbers. The converse was also true. Those cases in which ionization gave little or no relief were generally those in which the reagin content in the blood serum was relatively high.

In the period from 60 to 30 days before the beginning of the ragweed pollen season of 1934, 10 ragweed hay fever patients were tested and treated according to the following schedule:

Intradermal skin tests were done. The nasal mucosa was tested for sensitivity by the application of 1 drop of extract of whole ragweed pollen to the anterior tip of the right inferior turbinate. Starting with the dilution of 1-100,000 successively increasing concentrations were used until a definite reaction was secured. A sufficient time interval was allowed between tests to prevent cumulative action. After the degree of mucosal sensitivity had been determined, the patient was ionized and as soon as the nose appeared to be normal again, the skin and mucosal tests were repeated. The following is a tabulation of the results obtained in this experiment:

	BEFORE IONIZATION		AFTER IONIZATION		
Case	Skin Test	Mucosal Test Dilution	Skin Test	Mucosal Test	Relief from Symptoms Season of 1934
1	++	80,000	++	No reaction*	90% relief
2	+	50,000	++	No reaction	No symptoms
3	++	40,000	+	No reaction	No symptoms
4	++	70,000	++	1-1,000	20% relief Reionization done
5	++	80,000	++	No reaction	No symptoms
6	++	40,000	++	No reaction	80% relief
7	+++	50,000	++	1-5000	80% relief
8	++	30,000	+	No reaction	No symptoms
9	++	40,000	++	No reaction	No symptoms
10	++	50,000	++	No reaction	50% relief

*Where no symptoms appeared after application of 1 drop of 1-1000 extract it is recorded as "no reaction."

An analysis of this group of cases is interesting and certain conclusions seem to be justified.

1. There was little or no change in the skin tests after ionization.

2. Tests of the sensitivity of the nasal mucosa to dilutions of pollen extract exhibited a marked change after ionization. Although the nose appeared to be normal in each case after the treatment, it was apparent that some change had taken place in eight of the 10 cases whereby the shock cells of the nasal mucous membrane were no longer reactive to the atopen and in the two others a much greater concentration was required to produce a reaction.

3. These tests offered no criterion by which the symptomatic result from ionization might be predicted. The one case which, after treatment, still reacted to a dilution of 1-1000, exhibited typical symptoms in the second week of the hay fever season and 33 days after ionization. A repetition of the treatment still failed to give adequate relief. Five cases had complete freedom from the disease and the other four were quite comfortable.

It would appear from this experiment that one is justified in the conclusion that the physiological mechanism of relief is purely local and yet there have been many notable exceptions to this that could not be explained upon the basis of a local change in the nasal mucosa. The relief in certain cases of urticaria, asthma and migraine without nasal symptoms which have followed ionization of the nose are at least difficult of explanation upon this basis and suggest some more far reaching effect of the treatment. The complete disappearance of a 3+ skin test to orris root which followed ionization leaves the investigator even more in doubt.

Whether or not these immunologic studies before and after ionization will offer a criterion as to the result that may be expected from the treatment in any given patient, and will explain more fully just what happens during the process of ionization, can only be determined after a much larger series of patients have been studied. The preparation of such a series of carefully investigated cases is now well under way in the Department of Otolaryngology at Washington University and a further report upon this investigation at some future time is anticipated.

The criticism of this work by McMahon[19] and others, based upon the hypothetical damage that might possibly accrue to the nasal mucous membrane as the direct result of the ionization, is entirely without scientific basis. When we stop to think that we can entirely denude the maxillary sinus of its lining epithelium and yet in a few weeks find it completely covered with a ciliated mucosa which is functionally normal in every respect and in addition to this, considering the fact that the mucosa of the nasal chamber proper is much more resistant to trauma or environmental change than is that lining the sinus cavities, it is difficult to believe that, as the result of the slight irritative factor involved in ionization or other

Fig. 1. M. G., female, age 45 years.

similar procedures, any permanent damage would occur to the nasal mucous membrane; however, to be entirely certain about this point, sections of the nasal mucosa were removed from the noses of both animals and humans who had been previously ionized and these sections have shown, in every case, a complete return to normal with no microscopic evidence of pathology that could logically be attributed to the ionization.

Fig 1. This patient was ionized because of urticaria and asthma which had existed for more than 20 years. Both conditions have been so severe as to greatly interfere with her secretarial work. She has had three ionizations, Oct. 31, 1933, Dec. 5 and Feb. 6, 1934. She has now been entirely free of asthma since immediately following her first ionization and has had no recurrence of hives since the last ionization. This

patient was so grateful for the result secured that she was more than willing to have us remove a portion of middle turbinate, which was done under local anesthesia, June 5, 1934, more than four months following her last ionization. It will be seen that the ciliated layer of the mucosa is intact and normal in every respect. True, there is a slight fibrosis in the subepithelial layer, but no more than one would expect in a patient age 45 years. The glandular structures are entirely normal.

Fig. 2. W. P. L., male, age 40 years.

Fig. 2. This patient was ionized because of perennial nasal allergy for more than 15 years. During all of this time, the patient has been subject to recurrent attacks of sneezing, rhinorrhea and nasal obstruction. He had been subjected to all sorts of allergic investigation and therapy, from which he had received, as he termed it, "no good whatsoever."

Examination of smears from his nasal secretion showed a large proportion of the round cells present to be eosinophiles. All skin tests were negative. He was ionized April 16, 1934, with complete symptomatic relief and has remained so up to the present time. A small portion of middle turbinate was removed under local anesthesia June 30. This section shows a marked increase in the fibrous portion of the submucosa and some change in the epithelial layer. This change is in the direction of replacement of columnar epithelial cells with those of the squamous variety with some loss of the superficial glandular elements. The deep glandular structures are intact and normal.

When one takes into consideration the fact that this patient has been subject to recurrent attacks of nasal intumescence for more than 15 years, the residuum of submucosal thickening that is present in this case can be considered no more than normal.

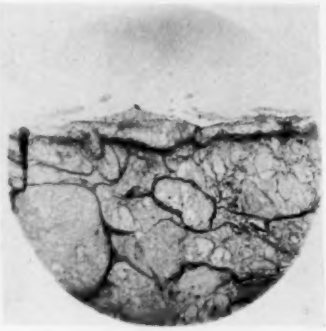

Fig. 3.

Fig. 4. M. F., male, age 64 years.

Fig. 3. This section is from a portion of the membrane removed from the nose three days after ionization. This membrane was gently separated from both the septum and the lateral wall of the nose and removed with forceps. The diagnosis is, of course, that of a coagulated transudate.

The deeper portion of this membrane is composed of fibrin enclosing many pockets which are filled with serum. The

superficial border shows a moderate degree of infiltration with round cells, but there is no evidence of necrotic remains of nasal epithelium along the separating line.

Fig. 4. This patient was referred by an eye specialist because of an allergic conjunctivitis, which had been present for several years and had been completely resistant to all other methods of therapy. The patient said that he had had hay fever every year for more than half a century. Smears from the secretions of both the nose and conjunctiva were heavily loaded with eosinophiles. This was our first case of ionization done for relief of an allergic eye condition and was carried out purely upon an experimental basis. The marked diminution

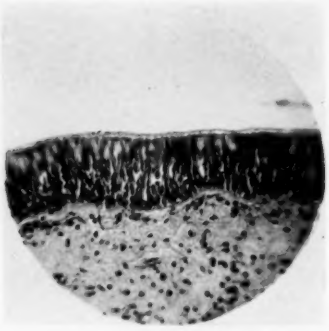

Fig. 5.

in the eye symptoms which followed the first ionization done Jan. 18, 1934, was so striking that a second treatment was requested and this was done 10 days later, Jan. 28. While the relief from the eye symptoms was not complete, it was so marked as to make the remainder of his eye treatments much easier. Another interesting fact is that, although this patient was ionized more than seven months before the onset of the 1934 hay fever season, he went through the entire summer with no symptoms referable to this disease.

The biopsy from his nasal mucosa was done five months after the first ionization.

This is a magnification of 58X showing mucosa, submucosa and normal glandular structures. The superficial ciliated layer of mucosa is normal and intact in every respect. There is a

moderate amount of fibrosis in the submucosal layer. Considering the fact that this patient is 64 years old and has had hay fever for more than half a century, this slight submucosal fibrosis can be considered as only normal in this case.

Fig. 5. This is a higher power magnification, 256X, of the last section. This shows the normal functional layer of the mucosa with its intact cilia covered with a blanket of mucus, the goblet cells and other structures in this layer being entirely within normal limits. There is the slight fibrosis in the submucosal layer, but entirely without round-cell infiltration or other evidence of inflammatory reaction or previous trauma.

During the last year and a half ionization along the lines suggested by Warwick has been used, not only in our own clinic, but it has been employed with success in the treatment of several of the manifestations of allergy by well recognized otolaryngologists all over America. A group of these men was asked to tabulate their results and the following slides represent a summary of the relief obtained by them in over 700 bilateral ionizations, all done for seasonal or perennial allergic rhinitis and asthma.

HAY FEVER, UNCOMPLICATED — TOTAL CASES, 416.		
Complete relief	260	63.4%
80-95% relief	46	11.2%
60-80% relief	17	4.1%
20-60% relief	54	13.1%
No relief	32	7.7%

Comment: Although the complete relief was only 63 per cent, if one adds to this the 80-95 per cent group, it gives 75 per cent of the cases that received 80-100 per cent relief following ionization. It is noteworthy that the complete failures in this group were only about 8 per cent. It must be remembered that the majority of these patients were ionized just before or after the onset of their symptoms last year and it is by no means expected that the same ratio of freedom from symptoms will hold good in these patients during the coming season. Certainly, some of them will have resensitized their nasal mucosa and will need treatment during this coming summer.

ASTHMA — TOTAL CASES, 27.	
Complete relief	10-37%
80-95% relief	3
60-80% relief	1
20-60% relief	1
No relief	12-44%

Comment: The per cent of relief obtained in this group of cases is only slightly more than half that in the preceding table and the failures are more than five times as many as occurred in hay fever. One possible explanation is that there have been included in this relatively small group several cases of asthma that were not of allergic origin.

HAY FEVER AND ASTHMA — TOTAL CASES, 161.		
	Hay Fever	Asthma
Complete relief	106-66.2%	85-53.1%
80-95% relief	14- 8.7%	13- 8.2%
60-80% relief	15- 8.9%	18-11.2%
20-60% relief	14- 8.7%	23-14.3%
No relief	12- 7.4%	21-13.1%

Comment: It is interesting to note that in this group, the 80-100 per cent figure of hay fever relief is exactly the same as that in the table for hay fever alone. The relief for the asthma in this group is much higher and the figure for failures much lower than in the preceding table, which was for asthma alone. This is probably accounted for by the fact that the asthma in all these cases was associated with hay fever and is thus definitely allergic in origin.

ALLERGIC RHINITIS — TOTAL CASES, 73.	
Complete relief	34-46.5%
80-95% relief	11-15.0%
60-80% relief	5- 0.8%
20-60% relief	14-19.1%
No relief	9-12.3%

Comment: The figure for complete relief in this series of collected cases is surprisingly low when compared with the results obtained in our own clinic. In our clinic the diagnosis of this condition is made only after having taken a careful allergic history and a cytological study of the nasal secretions and intradermal tests. Our results obtained by ionization in cases of perennial rhinitis of definitely proven allergic origin

are much better than these. My impression is that there have probably been included in this group cases of rhinitis that were not allergic and thus did not respond so well to ionization.

HAY FEVER AND ALLERGIC RHINITIS — TOTAL CASES, 28.

	Hay Fever	Allergic Rhinitis
Complete relief	22-78.5%	19-64.3%
80-95% relief		3-17.1%
60-80% relief	2- 7.1%	2- 7.1%
20-60% relief	1- 3.5%	1- 3.5%
No relief	3-17.1%	3-17.1%

Comment: The hay fever relief figure is again about the same as in the preceding tables. The figure for relief from allergic rhinitis, which is here probably properly classified, is more than 80 for the 80-100 per cent relief group. This is about the same that we have been able to obtain in similar cases.

CONCLUSIONS.

1. Nasal ionization following the technique elaborated by Warwick, when given after the hay fever symptoms have started, apparently stops the disease in the majority of patients for the remainder of the season.

2. About 75 per cent of cases of perennial allergic rhinitis are relieved of their symptoms following ionization.

3. The relief in cases of allergic asthma has been much less frequent, but there are still enough good results to warrant further investigation as to the causes of the failures.

4. Clinical observation and microscopic examination of nasal tissues removed from both animals and humans who have been ionized has thus far shown no evidence of permanent nasal damage which could logically be attributed to the treatment.

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Frisco Building.

THE DEVELOPMENT OF A BRONCHOSCOPIC SERVICE. WITH A REPORT OF 30 CASES OF ENDOSCOPY FOR FOREIGN BODIES.

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The work from which material for this paper was drawn was performed in the hospitals to which it has been accredited. Endoscopic procedures had not previously been carried out in these institutions to any extent. There were no instruments and there was no organization. Each situation presented difficulties peculiar to itself. The following remarks are intended to help the surgeon who finds himself alone in a previously unexploited field, and to show that with adherence to certain minimum essentials and the co-operation of the hospital, his difficulties can be overcome. The cases reported are concerned with endoscopy for foreign bodies only and no account is taken of the more numerous examinations made for diagnostic or therapeutic purposes. The author believes that in the comprehensive series, only one life was lost for which responsibility must be assumed. This case is reported in full at the end of the paper.

TECHNIQUE.

It cannot too frequently be repeated that the correct technique is the simplest technique, no matter how complicated it may appear. The best technique has been worked out in the clinics of Chevalier Jackson and his pupils in Philadelphia and has been described in textbooks and medical journals so that he who runs may read. It is not necessary, therefore, to repeat the details of this method. It is necessary, however, to issue a warning that he who seeks to simplify his problem by changing its essential principles is courting danger. The experienced endoscopist with a well organized staff may do good work in a number of different ways as the literature and observation will attest. This does not alter the fact, however, that the best technique is the only one with which to prepare for all eventualities with safety and confidence. Variations should be left until the organization is sound enough

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to withstand the introduction of notions. Of these notions the principal to be avoided are: *1.* The use of general anesthetics; *2.* The use of cocaine in children under 10 years of age; *3.* The use of the bronchoscope without the laryngoscope; *4.* The use of mechanical devices for the forcible exposure of the larynx; *5.* The replacement of the low table for the patient by a high scaffolding; *6.* The replacement of the trained assistant by head rests and mechanical arms.

ASSISTANTS.

Failure to expose the larynx or to pass the bronchoscope without the infliction of trauma or the use of force is no reflection upon the "high-low" method but rather upon its application or lack of application. The difficulty in many hospitals at the present time of securing the services of an assistant

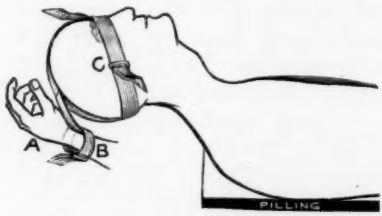

Fig. 1. Head band for bronchoscopy. The use of this appliance permits the untrained man to render the services of a trained assistant (see text for full description).

trained in head holding is the most important reason for bringing this technique into question and disrepute. There must be sufficient elevation of the head to bring the cervical trachea into line with the thoracic trachea and sufficient extension of the chin to displace the upper teeth out of line of the axis of the trachea and larynx. To overcome this difficulty the author has designed a head harness for the patient which helps the untrained man to render the services of a trained assistant without previous experience (see Fig. 1). A canvas strap, "C" adjustable at the front, passes around the patient's head below the glabella, over the ears and below the occiput. Opposite points in the circumference are united by a crown band which passes over the top of the head from front to back. From the center of this is suspended an adjustable wristband, "B" upon a pedicle of such length, as to allow it to reach slightly below the occiput. When the assistant's wrist is placed

within the wristband, his hand "A" necessarily falls into such a position that pressure will elevate the head. The associated tension on the pedicle produces the slight degree of extension of the chin necessary for easy instrumentation (see Fig. 2). The assistant who holds the shoulders must be instructed to retain them constantly in contact with the table; otherwise the advantage of elevating the head may be defeated by an accompanying elevation of the shoulders and straightening of the trachea is not obtained. The assistant must also maintain the shoulders in the midline of the table. In order to see the mouth of the left upper lobe bronchus, considerable displacement of the head and bronchoscope to the right is necessary.

Fig. 2. (A) Lateral X-ray view of neck in normal recumbent position. (B) Same as view (A). Laryngoscope in position and larynx exposed to direct vision. (C) Same view as (A). Bronchoscope inserted into trachea through laryngoscope. All exposures taken on living subject. Shoulders were not held during the taking of these pictures, showing that application of force is not necessary for the exposure of the larynx. The advantages of elevation and extension (see text) are graphically demonstrated.

If there is any rigidity of the patient's neck, the shoulders tend to rotate through the same arc as the instrument. Visualization of the upper lobe bronchus under such conditions is impossible, and the author has observed the work of one bronchoscopist who, after five years' experience had never seen this branch, because of his failure to correct this technical error. The importance of this point is emphasized by the fact that when the lesion is in the left upper lobe, shrinkage may pull the bronchus around the aorta and make it abnormally difficult to see.

The services of a nurse familiar with the instruments and the technique is of equal if not greater importance (see Case 1).

In bronchoscopy the operator is entirely dependent upon the nurse to place the proper instrument in his hand at the proper time and in the proper way. Without such assistance the situation is hopeless when quick and accurate work is required. The operator should insist whenever possible upon the permanent services of a graduate nurse. When this cannot be arranged it is better to secure the permanent attachment of a lay hospital employe, who can be released from other duties when necessary, than to attempt to work with the usual shifts of inexperienced student nurses. This lay person learns the operating room layout and the names, care and uses of the instruments. She is taught sterile technique and is allowed to scrub with a student nurse under the direction of the operating room supervisor. In this way better results are assured, the students acquire a greater fund of information and the hospital will save enough on decreased maintenance of equipment to warrant an increase in salary to the lay assistant.

ANESTHESIA.

There is room for improvement in the field of anesthesia. The endoscopist needs a safe local anesthetic for children under 10 years of age, and a local anesthetic for adults less toxic than cocaine. In spite of these shortcomings, however, peroral endoscopy should remain a minor procedure to be carried out under local anesthesia in adults and without anesthesia in children under 10 years of age. In connection with this field the same warning must be issued as was elaborated in the paragraph on technique — that he who seeks to simplify his problems by departure from fundamental principles is courting danger. General anesthesia is undesirable for the following reasons: *1.* It is unnecessary; *2.* The risk attendant upon the administration of a general anesthetic is unnecessarily introduced; *3.* If respiration is for any reason interrupted (occasionally unavoidable in endoscopy in children) under general anesthesia, death will probably ensue; under local anesthesia or without anesthesia, momentary interruption of respiration is practically without risk; *4.* The maintenance of a general anesthesia at a surgical level after the insertion of the tube is difficult and the accidental recovery of the patient during the operation may be attended with disastrous results; *5.* The conscious co-operation of the patient — the endoscopist's most valuable asset is lost; *6.* The cough reflex,

frequently essential as a diagnostic or therapeutic adjunct is absent under the deep general anesthesia necessary for the easy insertion of the bronchoscope.

Although general anesthesia has been advocated by careful and capable workers, including certain of recent date who recommend avertin for esophagoscopy, the author is unable to visualize any set of circumstances where general anesthesia is equal to local anesthesia for this procedure. On the other hand the author has witnessed several cases of near disaster arising from the use of avertin. In one instance the patient roused from the anesthetic as the surgeon was endeavoring to grasp a foreign body in the esophagus. A sudden movement of the head wedged the esophagoscope *in situ* and it was only after a struggle of more than half an hour that it was possible to remove the tube, leaving the foreign body undisturbed.

The author has never used general anesthesia for any endoscopic procedure either in children or adults. He has used several chemicals intended to serve as substitutes for cocaine, but has found none of them to take its place. In his opinion, however, he has found that it is possible to use cocaine with a much greater degree of safety than is frequently experienced. This is accomplished by applying the drug in progressively diminished concentrations. The author's technique is as follows. One cc. of 10 per cent cocaine solution is drawn into a laryngeal syringe. No anesthetic is applied to either the pharynx or pyriform fossae, but the entire attention is directed to an attempt to obtain satisfactory cocainization of the larynx and trachea. From five to seven drops are instilled into the larynx along the posterior border of the epiglottis. The remainder of the solution is then diluted with an equal amount of water, making a strength of 5 per cent cocaine. The epiglottis may then be caught by the tip of the syringe and pulled forward while an additional five drops of solution are allowed to trickle down the trachea. The solution is then brought down to $2\frac{1}{2}$ per cent by the addition of sterile water and the process is repeated. In this way a very satisfactory preparation of the patient may be obtained with a minimum of cocaine and likewise of risk.

TRACHEOTOMY.

Tracheotomy as a preliminary to bronchoscopy is a relic of the dark ages. Every bronchoscopist knows that any part of

the tracheobronchial tree visible through the bronchoscope inserted through a tracheotomy wound is visible through the instrument passed by the mouth. Nevertheless, cases of foreign body in the chest cavity occasionally fall into the hands of the general surgeon, who is sometimes inclined to recommend this procedure, and the inexperienced man might succumb to the allurements of this apparent detour to simplicity. The extremities to which such suggestions might lead are illustrated in the following case. A 15 months' old infant who had choked on a safety pin two days previously was brought to the writer by a general surgeon. He stated that he had not performed a tracheotomy because he thought that the whole thing would be better done at one sitting. The child had been able to take its regular diet. An X-ray showed an open safety pin about the middle of the thoracic cavity. Because it was more in the transverse than the sagittal plane, the suggestion was introduced that it might be in the esophagus. The surgeon objected on the ground that the child had had no difficulty in swallowing. Further X-ray study, however, showed the foreign body to be then in the stomach. The surgeon successfully removed it by open operation.

INDICATIONS.

It is a regrettable fact that many men, having discovered the larynx, consider that the possession of a bronchoscope constitutes them *ipso facto* as trained bronchoscopists. As one of these men put it, the bronchoscope is his "plaything." This is a most unfortunate attitude. Every foreign body — even the apparently simplest — is a potential death. Frequently the differentiation between foreign body and some other pulmonary condition is most difficult, and there may be urgent indications or contraindications to endoscopy, which call for quick and accurate diagnosis. The author has been called upon, on several occasions to perform bronchoscopies upon patients suffering from pneumonia, empyema, pleurisy with effusion, spontaneous pneumothorax, eventration of the diaphragm, tumors of the pleura and mediastinum, aneurysm of the aorta and one case of aneurysm of the left ventricle. The bronchoscopist deals constantly with diseases affecting the organs of the chest cavity. It would seem, therefore, superfluous, but nevertheless, it is necessary to say, that in order to apply to the greatest advantage his technical skill, the bronchoscopist

must be familiar at least with the fundamentals of the interpretation of X-rays of the chest (see Cases 2 and 3).

INSTRUMENTARIUM.

In the selection of instruments, danger arises from two sources principally. In the first place, the desire to use the largest possible bronchoscopic tube sometimes appears to be irresistible. The operator frequently chooses in the case of young children a tube which he thinks "ought to pass," but which in reality will not. Many otherwise careful operators have in this way precipitated a tracheotomy in uncomplicated cases and death has frequently ensued. The best way to avoid this difficulty is to make it a practice in the routine examinations for treatment or diagnosis, to use a tube which is smaller than the maximum possible size. In this way the surgeon becomes accustomed to working through small channels and is relieved of a dangerous temptation when faced with the important task of removing a foreign body in a child.

Difficulty arises in the second place from the dangerous error in judgment of looking upon the removal of a foreign body as a simple problem. Given this point of view, the operator may be lulled into a state of sufficient indifference to induce him to proceed with insufficient or defective equipment. If, however, he habitually works with the assumption, that death lurks in the shadow of every foreign body, this mistake will not be made. More than one life has been lost through the unavailability for immediate use of an extra bronchoscope or esophagoscope, a spare light carrier or battery cord, a tracheotomy set, or through the mechanical failure of some of the larger pieces of accessory apparatus, such as suction pumps (see Case 4) or fluoroscope. Endoscopy for foreign bodies is a life saving procedure and although it can and should be kept in the category of minor operations, it acquires major proportions. Meticulous care of equipment, rigorous supervision of technique and generous preparation for all emergencies will yield an ample reward at the most unexpected moments.

Case 1: J. S., white, male, age 2 years, was admitted to St. Vincent's Hospital (S. I.), March 25, 1933. The mother stated that the infant had always had some difficulty in swallowing with occasional regurgitation of food. On the previous day

STATEN ISLAND HOSPITAL GROUP.

Name	Age, Sex and Race	Foreign Body, Position and Sojourn	Anesthetic	Complications	Result
J. K.	W. male 28 yrs.	Steel wool in esophagus, pos. 1, 6 hrs.	Local.	None.	Removal. Cure.
D. S.	W. male 4½ mos.	Stewed apple in both bronchi, 1 day.	None.	Bilateral pneumonia. Edema of glottis. Tracheotomy.	Died 18 hrs. after bronchoscopy, 2 hrs. after tracheotomy.
A. E.	W. male 48 yrs.	Cotton pledget in left bronchus.	Local.	None.	Removal. Cure.
J. W.	W. female 36 yrs.	Common pin in right lung, 5 yrs.	Not bronchoscoped.	Bronchopneumonia and asthma.	Recovered from pneumonia.
W. W. *	W. male 5 yrs.	Supposed apple core in bronchus, 1 day.	Not bronchoscoped.	Bronchopneumonia.	Recovery.
A. G. *	W. female 2½ yrs.	Mucus plug in trachea, 12 hrs.	None.	Edema of glottis. Spon. pneumothorax. Reaccumulation of mucus. Tracheotomy.	Recovery from imminent death on bronchoscopic table 3 times. Died 4th time.
V. B.	W. male 22 mos.	Peanut in bronchus, 1 day.	None.	Trauma to throat — previous attempt at removal. Edema of glottis.	Removal. Cure.
H. M.	W. male 24 yrs.	Gold bridge in right bronchus, 2 mos.	Local.	None.	Removal. Cure.
O. A.	W. male 35 yrs.	Portion of denture in esophagus, pos. 1, 12 hrs.	Local.	None.	Removal. Cure.
B. S.	W. male 2 yrs.	Peanut shell in larynx, 1 wk.	None.	None.	Removal. Cure.
C. P. *	W. male 10½ yrs.	Common pin in stomach, 6 hrs.	None.	None.	Pin vomited up. Cure.
L. M.	W. male 9 yrs.	Drainage tube in right pleural cavity, 1½ yrs.	General.	None.	Tube removed from pleura.
B. B. *	W. female 58 yrs.	Chicken bone in left lung, 37 yrs.	Local.	Complete fibrosis of left lung.	No attempt made at removal.
L. M.	W. male 63 yrs.	Veal bone in left bronchus, 4 mos.	Refused bronchoscopy.	Multiple lung abscesses, left.	Bone coughed up. Died 3 mos. later.
J. L.	W. female 35 yrs.	Portion beef rib in esophagus, pos. 1, 2 hrs.	Local.	None.	Removal. Cure.
L. S. *	C. male 44 yrs.	Drainage tube in left pleural cavity, 3 mos.	None.	None.	Removal. Cure.

ST. VINCENT'S (S. I.) HOSPITAL GROUP.

Name	Age, Sex and Race	Foreign Body, Position and Sojourn	Anesthetic	Complications	Result
W. D.	W. male 35 yrs.	Meat bolus in esophagus, pos. 1, 24 hrs.	None.	Pre-existing stricture of esophagus (lye burn), 30 yrs.	Bolus removed. Stricture subsequently dilated. Cure.
M. L.	W. male 60 yrs.	Meat bolus in esophagus, pos. 2, 24 hrs.	Local.	Pre-existing stricture of esophagus (lye burn), 3 mos.	Bolus removed. Stricture subsequently dilated. Cure.
P. G.	W. male 21 yrs.	Meat bolus in esophagus, pos. 3, 12 hrs.	Local.	Pre-existing stricture of esophagus (lye burn), 2 mos.	Bolus removed. Stricture subsequently dilated. (Still under treatment.)
L. A.	W. female 10 yrs.	Dental drill in left bronchus, 3 hrs.	None.	None.	Removal. Cure.
M. C.	W. female 3½ yrs.	Nickel in esophagus, pos. 1, 4 days.	None.	None.	Removal. Cure.
D. N.	W. male 2½ yrs.	Penny in esophagus, pos. 1, 1 day.	None.	None.	Removal. Cure.
C. B.	W. female 3½ yrs.	Penny in esophagus, pos. 1, 12 hrs.	None.	None.	Removal. Cure.
M. J.	W. female 60 yrs.	Portion of veal rib in esophagus, pos. 1, 1 day.	Local.	None.	Removal. Cure.
E. L.	W. male 70 yrs.	Portion of veal scapula in larynx, 2 days.	None.	Patient in moribund state. Edema of lungs.	F. B. removed. Patient died 6 hrs. later.
J. S. *	W. male 2 yrs.	Penny in esophagus, pos. 2, 2 days.	None.	Perforation of esophagus and mediastinal pleura. Pneumothorax.	Died 1 day later.

RICHMOND MEMORIAL HOSPITAL GROUP.

Name	Age, Sex and Race	Foreign Body, Position and Sojourn	Anesthetic	Complications	Result
M. W.	W. female 36 yrs.	Crab shell in esophagus, pos. 1, 1 day.	Local.	None.	F. B. displaced and swallowed on operating table. Cure.
J. S.	W. male 53 yrs.	Portion of denture in esophagus, pos. 3, 1 day.	Local.	Three sharp points upward. F. B. had to be rotated.	Extraction. Cure.
T. F.	W. female 52 yrs.	Needle in right pyriform fossa.	Local.	Needle held between larynx ant. and vert. col. post. Broke during withdrawal.	End of needle left in larynx. Cure.

SEA VIEW HOSPITAL CASE.

Name	Age, Sex and Race	Foreign Body, Position and Sojourn	Anesthetic	Complications	Result
P. M.	W. female 32 yrs.	Drainage tube in left pleural cavity.	None.	None.	Tube removed from pleura.

In the above cases "Position 1" is used in reference to foreign bodies arrested at the level of the cricopharyngeus inferior muscle; "Position 2" to those arrested in the middle of the thoracic cavity near the aortic construction; "Position 3" to those arrested at the level of the diaphragmatic pinch-cock.

the child choked on a penny and since then swallowing had been increasingly difficult. He was still able to take liquids.

X-ray showed the penny to be in the esophagus at the level of the aortic constriction. On March 25 an attempt was made to pass a 7 mm. tube. The esophagus was found to be abnormally narrow in lumen and fixed in the midline, so that every attempt to insert the esophagoscope resulted in complete stoppage of the respiration. A 5 mm. tube was then substituted. It was found that the penny could be reached with this instrument, but in order to obtain a good exposure it was necessary to swing the tube toward the midline with complete interrup-

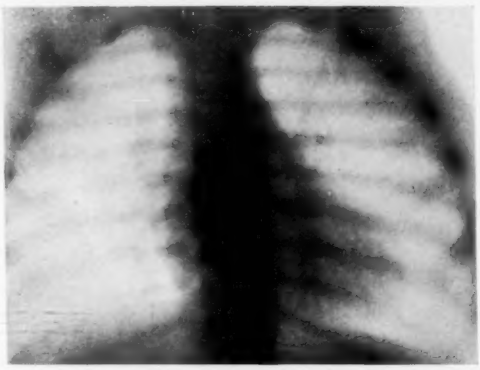

Fig. 3, Case 1. X-ray of chest showing penny in esophagus slightly below position.

tion of breathing. This was deliberately done, but in the excitement of the moment the operator was handed a suction tube instead of grasping forceps. Because of the time lost in obtaining proper forceps it was necessary to seize the penny quickly and withdraw rapidly. The foreign body escaped from the insecure grasp as the mouth of the tube was passing the constrictor pharyngeus muscle. Artificial respiration was resorted to and the child regained consciousness. A second X-ray showed the penny to have returned to the same position. On the following day a second attempt was made with a 5 mm. tube, but on this occasion the coin was found to be hidden by massive edematous swelling of the mucous membrane. The previous maneuver of displacing the end of the tube medially

was unsuccessful in effecting an exposure. It was decided as a last resort to allow the child breathing space by lateral displacement of the tube and to attempt to insinuate it past the penny and then to displace it upward on the lip of the esophagoscope. The manipulation was successful and the foreign body was grasped and removed without the necessity of restoring the child by artificial respiration. On the morning of March 27, the child was found to have an almost complete pneumothorax on the right side. A deflation mechanism was at once put into operation with immediate complete re-expan-

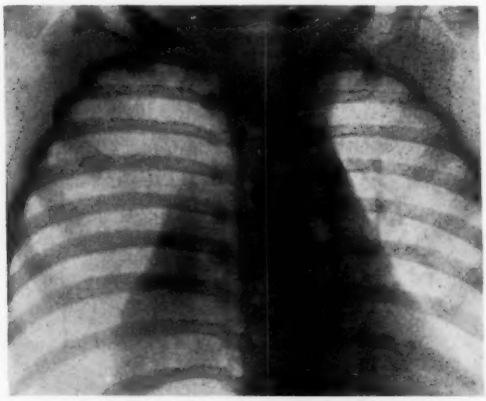

Fig. 4, Case 1. X-ray of chest after removal of penny. There is complete collapse of right lung.

sion of the lung. The pleural cavity, however, was found to contain gastric contents. The infant died a few hours later.

Postmortem examination was not permitted. An examination of the mother's blood gave a 4+ Wassermann reaction. It is believed that this child suffered from a posterior mediastinitis of congenital luetic origin. At any rate, it forcibly presents two important points, both of which are elements of danger: *1*. An unexpected complication to an otherwise simple foreign body problem; *2*. The lack of an efficient organization to cope with an emergency.

Since that time provision has been made by the hospital to remove the danger of further accidents on this account.

Case 2: R. W., white, male, age 5 years, was admitted to the Staten Island Hospital on Oct. 31, 1930. The family stated that the boy "had not been himself for a few days," but that he had not really been ill and had not been kept in the house. On the morning of the day of admission he choked on an apple core while playing in the street. He had a severe coughing spell, a doctor was summoned and the child was admitted to the hospital. On examination he presented the classical picture of pneumonia with slight cyanosis. His tem-

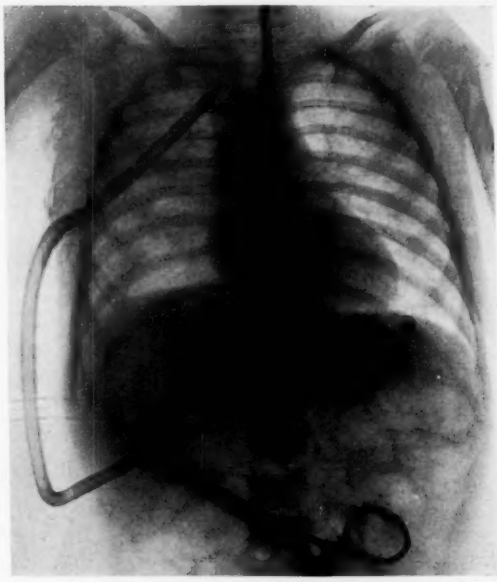

Fig. 5, Case 1. X-ray of chest 45 minutes later than Fig. 4 and after using deflation apparatus for about 15 minutes. Lung is completely re-expanded. Stomach tube can be seen in position.

perature was 104° F.; pulse, 120; and respirations, 34. His white cells numbered 11,000. There were exquisite signs of consolidation of the lower two thirds of the left lung, but no evidence of atelectasis, bronchial obstruction or irritation or other of the common accompaniments of foreign body. X-ray of the chest was normal.

In spite of protests, the author advised against bronchoscopy and the family were given permission to transfer the child to

another hospital. On the advice of Dr. Robert Shields, the surgeon referring the case, this action was postponed and about six hours later the temperature fell by crisis. The patient made an immediate and complete recovery.

This case illustrates the difficulty and the urgency at times, of deciding upon the indications for bronchoscopy. Such an examination on admission might have comprised the outlook for a rapid recovery. It also challenges our ability to render an accurate diagnosis. It belongs undoubtedly in the group of "aberrant pneumonias" or "pneumonias of short duration," which are reported from time to time and is best explained by the assumption that the alveolar spaces are filled with a tran-

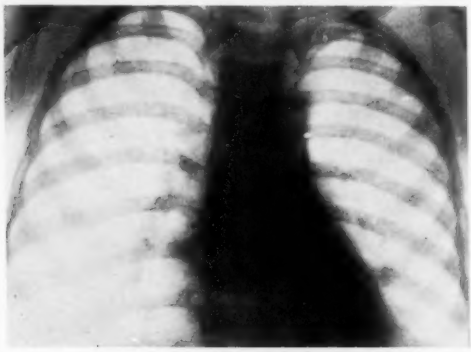

Fig. 6, Case 2. X-ray of chest taken during the sojourn of what was clinically a pneumonic consolidation of the greater part of the left lung. Apart from a slight diminution in volume of the left hemithorax there is nothing abnormal to be seen.

sudate of watery serum. This would account for the physical signs of consolidation, while the absence of hemoglobin, nuclear material or other substance of high atomic weight would account for the absence of X-ray shadow. This patient was X-rayed three times in the first 24 hours. The last radiograph, taken when he was comparatively well, showed a slight veil-like shadow over the lower part of the left lower lobe.

He was discharged, cured, three days later.

Case 3: A. G., white, female, age 2½ years. Three weeks previous to admission the patient had had the third of her series of toxin-antitoxin treatments for immunization against diphtheria. The parents blamed this for the onset of her ill-

ness. She had had a "husky voice" for three or four days, when she was suddenly seized with coughing and difficulty in breathing. An ambulance was called and she was admitted to the Staten Island Hospital, March 27, 1933. On examination she was slightly cyanotic, showed marked suprasternal and epigastric retraction and obvious air hunger. The temperature was 102°, rising to 104° F.; pulse, 140. The usual therapeutic measures were instigated with temporary mitigation of symptoms. The patient, however, later became worse and at 11 P.M., a bronchoscopy was performed. The larynx was swollen and presented an ashen grey color, while immediately below it appeared a mass having the color and consistency of par-

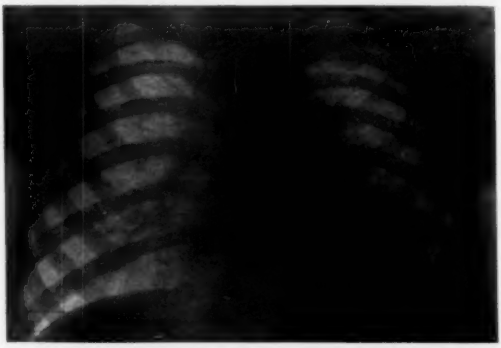

Fig. 7. Case 2. X-ray of chest taken 20 hours later than Fig. 6. There is partial opacity of entire left lung field. Patient at this time clinically much improved and on the way to rapid recovery.

tially dried fish glue. Respirations and the heart beat promptly ceased, and it was necessary to thrust the bronchoscope through this mass and resuscitate the child with direct insufflation of oxygen and carbon dioxide. The mass was then removed from the right bronchus, piecemeal. A tracheotomy tube was inserted with the bronchoscope *in situ* and the child was returned to the ward in a comfortable condition. The obstruction had the appearance of partially coagulated mucus and serum in the laboratory.

On the following day symptoms gradually returned in spite of constant suction and the removal of several pieces of mucus through the inner tracheotomy tube. In the afternoon there was a return of suprasternal and epigastric retraction. An

X-ray of the chest on admission had been reported normal. A repeat X-ray taken at this time was reported by Dr. H. L. Halbert to show a spontaneous pneumothorax of 65 per cent on the right side. As in the previous case, it was necessary to arrive at an emergency decision in reference to the indications for bronchoscopy. It was decided that the pneumothorax was due to the rupture of an emphysematous bleb, and its extent due to the rarefaction of the air accompanying the highly negative pressure induced during inspiration. The parents were recusant on account of the failure of the first bronchoscopy to provide permanent relief. Aggravation of the

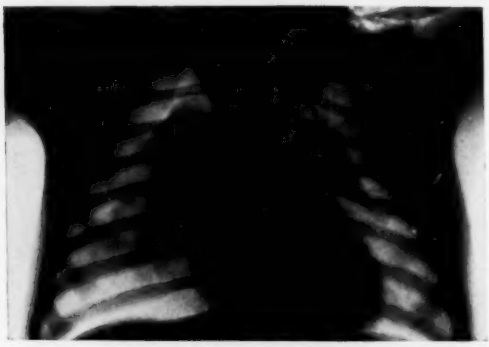

Fig. 8, Case 3. X-ray of chest showing right-sided pneumothorax of 65 to 75 per cent. An emergency decision was required to decide the relative importance of tracheal obstruction or pneumothorax in the production of dyspnea. Tracheotomy tube can be seen in situ.

symptoms, however, necessitated bronchoscopic relief at 6 P.M., 19 hours after the performance of the first. The experiences of the first session were repeated. The child died, to all intents and purposes on the operating table and required resuscitation by intratracheal insufflation. As before, she returned to the ward breathing comfortably. An X-ray of the chest taken about two hours later showed the right sided pneumothorax to amount to only about 10 per cent.

The same series of events was repeated on the following day, with imminent death on the operating table and resuscitation. On this occasion the emergency was precipitated by the inability of the author to reach the hospital in time. Bron-

choscopy was performed the third time exactly 19 hours after the second.

Fifteen hours later the child suddenly became dysponic and was rushed to the operating room for bronchoscopy. On this occasion, however, she died on the table and failed to respond to all efforts to revive her.

Fig. 9. X-ray of chest taken two hours after removal of plug of coagulated mucus and serum from right stem bronchus. Pneumothorax is now reduced to from 5 to 10 per cent. Patient was then breathing comfortably.

Fig. 10. Author's bronchoscopic glasses. Prescription lenses may be used in the frames. The rotary discs made of optical glass protects the eyes from infection and provide an ample reserve of clear visual fields. (For description see Archives of Otolaryngology, Aug., 1933, Vol. 18, p. 201.)

Case 4: White, male, age 10½ years. The patient choked while eating a veal stew and continued afterward to complain of substernal pain. The parents sought the advice of Dr. A. A. Shapiro, who admitted the child to the Staten Island Hospital on Feb. 1, 1933. An X-ray taken on admission showed the pin to be located in the extreme cardiac portion of the esophagus, point upward. On account of the large

amount of food contained in the stomach esophagoscopy was carried out on the biplane fluoroscopic table and a portable suction apparatus was brought into use. As soon as the diaphragmatic pinchcock was opened, stomach contents began to ascend into the mouth, requiring constant removal by suction and necessitating complete reliance on fluoroscopic control. Under the direction of Dr. H. L. Halbert at the fluoroscope the pin was grasped and removal was begun. At about one inch above its original location, however, the pin resisted removal and further localization became necessary. At this juncture the suction pump ceased to function, allowing gastric contents to accumulate in the mouth with the danger of flooding the lungs. It was necessary to abandon the attempt at the very moment when success seemed certain. Fortunately the child vomited up the pin about two hours later, and was discharged, cured, on the second day following.

This case needs no comment, but is reported in detail because it emphasizes, in dramatic fashion, the necessity for constant supervision of instruments and equipment to maintain them in the maximum state of mechanical perfection.

All appliances described in this article are manufactured by The George P. Pilling & Son Co., Philadelphia, Pa.

30 Central Park South.

IN MEMORIAM

DR. DUNCAN CAMPBELL SMYTH,
1885-1935.

Duncan Campbell Smyth was born on May 8, 1885, at Port Hood, Nova Scotia. He was the son of Christopher Smyth and Ellen Somers and grandson of the Hon. Peter Smyth. He died June 11, 1935.

He was educated at Port Hood Academy and the University of St. Francis Xavier's College in Antigonish, Nova Scotia, where he received the degree of Bachelor of Arts, in 1904. Following the footsteps of his brother, the late Dr. P. Somers Smyth, prominent eye specialist of Boston who died in 1929, he entered the Harvard Medical School and graduated therefrom in 1909. He interned at the Massachusetts Eye and Ear Infirmary and thence practiced in Boston.

On Jan. 1, 1914, he married Alice G. Rice, who with two children, a daughter, Pauline, age 17 years, and a son, Duncan, age 20 years, survive him.

Dr. Smyth was a Senior Surgeon in the Department of Otolaryngology at the Massachusetts Eye and Ear Infirmary, was a finished operator and made a distinguished name for himself in bronchoscopy and esophagoscopy. He invented two bronchoscopic instruments, and one operation bears his name. His record in removing foreign bodies from the bronchi is exceptionally brilliant. He was distinguished for his good judgment and his dislike of fads and sham. He was one of the first to recognize the value of the formation of the Thoracic Clinic at the Massachusetts General Hospital and was the strongest representative of the Infirmary on this service. His opinions were highly valued by the members of this group; in the American Bronchoscopic Society, of which he was Vice-President a year or two ago, his opinion was equally valued.

Dr. Smyth was not given to much speech. He had a dry wit which brightened any discussion. He usually spoke last, and had the gift of hitting the nail on the head; when necessary he could hit hard. In the Wednesday Clinical Meetings everyone felt that the meeting would be a success if he was there, and generally he was. He made the hospital his first interest. He did not wait until his time of service came around to

appear; nearly every morning he would show up ready to tease somebody and to help everybody. He was a bit old-fashioned in some ways, especially in his loyalty and respect for his superiors. He was a splendid companion and thoroughly a man's man.

He was a member of the American Laryngological Association, the American Otological Society, the American Rhinological, Laryngological, and Otological Society, the American Academy of Ophthalmology and Otolaryngology, and the Massachusetts Medical Society. For many years he was instructor in Laryngology at the Harvard Medical School.

Dr. Smyth was at the height of his powers at his death. He was next in line for senior positions in medical societies.

Dr. Smyth was interested in civic affairs and was a member of the Board of Trade of Marshfield. He was a lover of birds and dogs. He took great interest in the many birds about his Marshfield home.

A few years ago Dr. Smyth bought for summer use a house at Marshfield, Mass., which Daniel Webster built for one of his sons, and in which at various times Webster himself had lived. Dr. Smyth had long been an admirer of Webster, and he began to collect Websteriana. In the Webster room of Dr. Smyth's house a number of valuable Webster relics were found and transferred to the town authorities. In his pursuit of Webster material he made a regular and systematic round of the second hand book shops.

He was a member of the Harvard Club, of Boston, and until recently a member of the Boston Art Club. H. P. M.

DR. ROBERT CARROLL HOWARD,

1884-1935.

Dr. Robert Carroll Howard, of New York City, died suddenly of a heart attack on May 4, 1935, at his home at Awosting, N. J.

Dr. Howard was born in Frederick, Md., but had practiced in New York for 20 years and had a successful and interesting career. He was a graduate of the College of Pharmacy, City of New York, and of Cornell University Medical College, in 1911. For 10 years he was a member of the faculty of Cornell University Medical School and College; for seven years a member of the faculty of the Manhattan Eye, Ear, Nose and Throat Hospital and at the time of his decease was Adjunct Professor of Otology at the New York Hospital and Consulting Physician at St. Elizabeth's Hospital.

The deceased was four times President of the New York Medical Union and won marked recognition as the result of the "window operation" on the ear, which he devised and performed with splendid results. A description of the article appeared in this journal in February, 1935.

Indefatigable in his efforts in the interest of his profession, the cause of education generally, his church and other affiliations, as well as his family and friends, he possessed a brilliant mind, a keen appreciation of the arts, a gentle and generous nature, a distinct cordiality of manner and an abiding faith in humanity. He was a member of the American Medical Association, a Fellow in the American College of Surgeons, a member of the American Laryngological, Rhinological and Otological Society, the New York Academy of Medicine and other professional groups; also the Maryland Society of New York, the Southern Society of New York and the New York Society, Sons of the American Revolution; a member of the Board of Directors of the Awosting Association and a member of the Awosting Country Club.

A widow; one son, Robert Carroll Howard, Jr., New York City; one sister, Mrs. Eleanor Howard Tull, Frederick, Md.; and a brother, Donald F. Howard, New York City, survive.

Funeral services were held, May 8, in St. Michael's Episcopal Church, New York, of which the deceased was a member and vestryman, with burial at Kensico Cemetery, N. Y.

M. A. G.

DR. JOSEPH HAMMOND BRYAN,

1856-1935.

Dr. Jos. Hammond Bryan, pioneer otolaryngologist of Washington, D. C., died at his home, Feb. 3, 1935, of cerebral hemorrhage, at the age of 78 years.

Dr. Bryan was born, July 4, 1856, in Washington, D. C., where he obtained his preliminary education, later attending the University of Virginia, receiving his M.D. degree there in 1877. After graduation he interned one year at Charity Hospital, Blackwell's Island. Entering the Navy as Assistant Surgeon in 1880, he remained in service until 1885, when he resigned to devote himself to otolaryngology. After two years of study in Europe he returned to Washington to engage in the practice of this specialty. He was a prolific writer, having contributed numerous articles to the various journals in his special field.

During the World War Dr. Bryan served as Major in the Medical Corps. He was a Fellow of the American Laryngological Association and for a number of years served as its Librarian, the American Otological Society, Inc., the American College of Surgeons; a member of the American Board of Otolaryngology, the American Academy of Sciences and the Philosophical Society of Washington. His clubs were the Metropolitan, Cosmos and Chevy Chase.

Dr. Bryan had never married and made his home with his two sisters, who survive him and to whom we offer our heartfelt sympathy.

His wise counsel and vast experience will be sadly missed in the otolaryngologic world. M. A. G.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY.

SECTION OF OTO-LARYNGOLOGY.

Meeting of Jan. 11, 1935.

DR. J. J. HOCHFILZER gave a further report on a case of arteriovenous fistula between the right temporal artery and vein.

Three months ago the writer presented this case of arteriovenous fistula between the right temporal artery and vein before this Academy. In the discussion of the surgical procedure of the case, it was brought out that a ligation of the external carotid artery would remedy this condition. The writer expressed his doubts as to the efficiency of such a procedure alone, but decided to try it, thinking that a ligation of the external carotid artery would at least be of help at the time of the second operation, if that was found necessary, in greatly reducing an excessive hemorrhage by cutting off the main branch of the fistula.

Two months ago, under local anesthesia, the external carotid artery was ligated just above the point from where the lingual artery branches off. The jugular and facial vein, in which the temporal artery emptied, were found to be greatly dilated — about twice the normal size. The effect of this procedure was a temporary disappearance of the bruit and pulsation at the aneurysm; but one week after the operation these symptoms again made themselves evident; which proved that the fistula was still supplied with arterial venous blood by a collateral circulation.

Three weeks later the arteriovenous fistula was exposed, the proximal and distal ends of the temporal artery were ligated, and the whole fistula excised.

The patient made an uneventful recovery and no damage to the facial nerve or parotid gland was noticed.

DR. CHARLES E. CONNOR reported a case of tumor of the neck to which he had appended the diagnosis of "laryngocele."

The patient, a man, age 64 years, complained of increasing difficulty in swallowing and occasional slight difficulty in breathing. The only thing of significance in the history was a cough which had been present for several weeks.

Physical examination was negative except for a tumor which presented in the neck anterior to the sternomastoid well below the ramus of the mandible. Indirect laryngoscopy showed a small tumor mounding up between the wall of the pharynx and the larynx, pushing the latter to one side and causing some folding of the epiglottis; no tumor was visible inside the larynx and the cords moved in normal fashion. There was no dyspnea but there was a little difficulty in swallowing.

X-ray without opaque media showed what appeared to be an air-containing sac lying in the side of the neck. Aspiration of the tumor through the pharynx was negative. Injection of lipiodol outlined the tumor quite well, but did not demonstrate any connection with air or food passages, a fact which raised some question as to its exact origin and character.

The tumor, which was easily removed under local anesthesia through a collar incision, measured approximately 5.5x3.5x3.5 cm., was egg-shaped, and looked like a small bladder; the lipiodol, which had been injected a few days previously, could be seen through the thin transparent walls.

(Slides of the X-ray plates of the case under consideration, and of pictures of anatomical preparations of the larynx from the article by Irwin Moore in

the Journal of Laryngology, 1922, were shown. The table of pathological conditions of the laryngeal saccule is also from Moore's article.)

Pathological and morbid conditions of the laryngeal saccule (Moore). 1. Hydrops (unobserved). 2. Mucocele (unobserved). 3. Pyocele. 4. Pneumatocele — a. Laryngocele. b. Hernia. 5. Eversion of the sacculus — a. Without eversion of the ventricle. b. With eversion of the ventricle. 6. Gland cysts of the wall of the sacculus (either with or without eversion). 7. Solid tumors of the sacculus.

Dr. Connor said he had not succeeded in finding many cases in the literature. Extralaryngeal tumors offer no particular difficulty in their surgical treatment and are not attended by severe symptoms. Intralaryngeal tumors, such as hernia of the saccule into the airway, may easily cause embarrassing or urgent symptoms; they are most easily attacked by an external approach.

DISCUSSION.

Dr. Kenneth Phelps said Dr. Connor had beautifully demonstrated the anatomy of the saccule which is an extension of the anterior portion of the ventricle.

As Dr. Connor pointed out, there exists some confusion regarding the term "laryngocele." A good example of this confusion is the definition of laryngocele which appears in Jackson and Coates: "Laryngocele is the occurrence of an unusual widening of the laryngeal sinus (ventricle), either unilateral or bilateral. The hernial protrusion of the mucous membrane may lie (a) within the larynx or may be turned on itself, or (b) may project as a hernia through the hypothyroid membrane and appear externally as a subcutaneous larynx analogous to the air sac which is present in apes."

Dr. Phelps said he had had a case of cyst of the saccule which was congenital and had been present for 20 years before it came to operation. This was operated upon externally and the cyst was found above the thyroarytenoid muscle. This patient had a congenital lack of fusion of the thyroid cartilage.

Dr. Phelps said he was not sure, from the description, whether in Dr. Connor's case the cyst was really connected with the larynx. Dr. Connor had stated that examination of the larynx showed no difficulty in motion of the cord, and it being present in the pharynx made Dr. Phelps wonder if it could be classed as an ordinary diverticulum of the pharynx.

Dr. L. R. Boies said that with Dr. Connor's permission he wished to exhibit a specimen of a laryngocele which he had removed about two years ago. You will note that it is a direct diverticulum of the ventricle and is about five times the normal average size of this structure.

The story in this case is interesting. The patient was an elderly appearing lady, age about 66 years. While returning from abroad, she became hoarse and was treated for laryngitis by the ship physician. The writer saw her for the first time about eight weeks later. In addition to a marked hoarseness, she then exhibited a moderate stridor. Mirror laryngoscopy revealed a white, fuzzy proliferation which partially fixed the left vocal cord. The patient's husband had had syphilis and her mother had died of pulmonary tuberculosis. A careful study of the individual failed to reveal any evidence of disease except for the condition in the larynx. A biopsy indicated a chronic inflammatory tissue.

Because of the size of the swelling and the stridor, a thyrotomy was performed under local anesthesia. When the involved side was examined with the larynx opened, a granuloma was noted involving the true cord and there escaped from the recess of the ventricle a considerable amount of glary mucus. The usual thyrotomy procedure, as for an intrinsic malignancy of a vocal cord, was followed, removing a block of tissue with the diverticulum. Microscopic studies of the removed tissue could not establish a diagnosis other than chronic inflammatory tissue with some giant cell reaction.

(To be continued in subsequent issue.)